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NOTES AND COMMENTS.

The Museum in Epping Forest.

IN our "News" pages we give an account of the opening of the Epping Forest Local Museum. Through the kindness of Mr. William Cole, Honorary Secretary of the Essex Field Club, we are enabled to

publish the accompanying excellent drawing by Mr. H. A. Cole. It represents the south aspect of Queen Elizabeth's Lodge, Chingford, which, by permission of the Committee of the London Corporation, is now occupied by the Essex Field Club's Museum.

Trustees for Local Museums.

At the opening of the Epping Forest Local Museum, Sir William Flower raised the important question of the permanence of such institutions. Remembering how many local museums depend for their success on the efforts and enthusiasm of one or two individuals, whose death or removal is synonymous with the decay of the collection, Sir William asked what guarantee the Essex Field Club could afford that valuable donations to its new museum would always be preserved with the same care that would undoubtedly be bestowed upon them by the first Honorary Curator, Mr. Cole. Unless some guarantee of this kind were forthcoming, he thought that many would-be donors, especially those having archæological specimens, would hesitate before handing over their treasures to the care of the Club. He did not venture upon any suggestion, and his responsible position as an officer of the British Museum would, perhaps, hardly permit him to refer to any scheme of affiliation of the various local museums with those directly supported by the State. We think, however, it is high time that some such scheme were seriously considered. A bequest made many years ago to the Bristol Museum was accepted by the Trustees of the British Museum as a reversion, in case at any time the former institution should collapse or fall into destructive neglect; and when the Bristol Corporation lately undertook the control of this museum, it was necessary first to convince the Trustees of the British Museum of the perfection of their arrangements, before the transfer of the property could be effected. It is too much to expect that the already overburdened body of eminent men just mentioned should undertake similar responsibilities throughout the kingdom; but we see no reason why a State Commission should not be appointed to work in conjunction with the Science and Art Department, the Trustees of the British Museum, and those of the National Gallery, to maintain a general oversight over all local collections and bequests entrusted to their care. The Commission might be constituted much on the same lines as that dealing with the preservation of ancient monuments. As in the case of the latter, the recognition of the Trusteeship of the State Commission should be an entirely voluntary matter; but donors would soon begin to favour those museums where such a guarantee for the safe custody of their specimens existed.

We could mention many lamentable instances in which a controlling organisation of the kind suggested might operate with advantage to the devotees of natural science. It would be difficult, however, to find a more striking illustration than that afforded by the Moore Collection of Fossils at Bath. No geologist can visit the Bath Literary and Philosophical Institution without feeling deep and just indignation. The specimens are nominally under the care of an accomplished honorary curator of wide experience, universally respected by his fellow geologists; practically, his advice is set aside

by a preponderance of conflicting interests, and the result is a disgrace to any body of educated men at the end of the nineteenth century. Beautiful slabs of rock with delicate projecting skeletons of reptiles are left to the tender mercies of the audiences who crowd into the *quondam* museum, attending lectures and entertainments. Ugly pieces of wood are nailed across the frames, and occasional pieces of coarse netting testify to at least some qualms of conscience on the part of the Bath Committee. If these precious specimens are to be kept apart from the remainder of the collection and to decorate a lecture hall, they ought to be covered by secure glass cases, which would preserve them from accident and mischievous fingers. Better still if the subscribers who purchased the Moore Collection for the native town of the geologist who amassed it, had the opportunity of making some competent State Commission its permanent trustee, and rescuing it from the vagaries of a mixed local committee.

Local Museums and Educational Bodies.

But if men of eminence cannot easily be found to serve as trustees for local museums, or if the local authorities are unwilling to place themselves beneath the official thumb, yet there is another way out of the difficulty, and one which has occasionally been advocated in our own pages. We are reminded of it, not only by the speech of Sir William Flower, but by some notes on the subject which appeared in the *Leeds Mercury* for October 20, and which endorse the suggestions that we have previously put forward. The kernel of the scheme is closer co-operation between the local museums and the local educational bodies. Many of our great public schools have started museums for natural history, or other purposes, and the services which such museums render to education will hardly be denied by anyone who has read the accounts which have from time to time been published in this Journal. But if museums and other collections are of use to the schools, similarly the schools may be made of use to the museums. Certainly such institutions as Eton and Winchester, or as the numerous Grammar schools scattered about our country, are not by any means so liable to extinction, or even to change, as are the committees or individuals that often have the control of local museums. Consequently, in the words of the *Leeds Mercury*:

"In towns where there exist a local museum and a local Grammar school, it is proposed that the latter should 'take over' the former, have the contents thoroughly overhauled, weeded-out, properly classified, and accurately and succinctly labelled, and 'housed' in a special building in close proximity to the school. By this means such museums would be made to serve a good educational purpose, and—as in the United States in particular—there should be no difficulty in arrangements being made for the preservation of their 'popular' element by the museum being thrown open to the public on certain days of the week. It is suggested, also, that whatever endowment funds these institutions may be possessed of should be

appropriated at the same time, and their management placed in the hands of Governors, who would be, as a matter of course, gentlemen of education, who would take care that the museum was not made the dumping-heap for all sorts of bequests, the indiscriminate acceptance of which makes scientific classification impossible. Certainly, there is a great field for improvement, and the direction of reform suggested has some good, practical features about it."

DR. HERTWIG ON THE CELL.

WHEN the original edition of Oscar Hertwig's treatise on the cell appeared, we reviewed it at considerable length (NATURAL SCIENCE, ii., p. 225). It is unnecessary to devote part of our columns on new books to praise the excellent translation of the work, edited by Dr. H. J. Campbell, and recently issued by Messrs. Swan Sonnenschein (London, 1895, price 12s.). At the present time, when the cell-theory is a topic of the day, this careful and accurate translation of a work by, perhaps, the leading exponent of the theory is unusually welcome. As Hertwig points out, a whole series of conceptions clusters round the term "cell," and although in many respects "the cell-theory is the centre around which the biological research of the present time revolves," it cannot be said that our present conception is final or perfect. Roughly speaking, the chief stages in the series of conceptions are these. Originally, the term cell was applied to the small room-like spaces, provided with firm walls and filled with fluid, to be seen in plants. The wall was the most striking occurrence, and the name arose from this. The continuance of the name, now that the idea is incongruous with it, has led, we think, to an appearance of conflict when no real conflict exists. But we cannot agree with Mr. Bourne's approval of the word "cyte" as a substitute; for the idea "box" retains precisely the error of the word "cell." It is not an enclosed space, but a localised piece of matter that we wish to name. The second term in the series of concepts is due chiefly to Max Schultze; the cell-wall was regarded as an "accident" of the cell. The cell was a small mass of protoplasm endowed with the attributes of life. While this idea ruled, the question arose as to whether or no every cell had a nucleus; improvements in the method of observation, and extension of actual observations, led to the conviction that the nucleus was an essential factor of the cell. This gives us the last definition of the concept; the cell is a little mass of protoplasm, which contains in its interior a specially-formed portion, the nucleus. The problem over which Mr. Sedgwick and others do rage exceedingly, seems to us to be not much more, in essence, than this: round each nucleus there is a mass of protoplasm, in most cases plainly dominated by the nucleus; are the mass of protoplasm and the included nucleus necessarily bound together as an individual, or may the nucleus move through the protoplasm and acquire a new "sphere of influence"?

The Cell in Botany.

The gradual change in the idea "cell" is most plainly written in Botanical History. Botanists retained the conception of the cell-wall, combining with it Max Schultze's protoplasmic idea. In the older text-books the plant unit is a "cell," *i.e.*, a cellulose chamber enclosing protoplasm and cell-sap. An aggregation of such, like bricks in a wall, formed a tissue. The brick-wall metaphor was an unfortunate one. It gave quite a wrong impression of the origin of tissues, for the bricks are separate structures brought together to form the whole, whereas the cells of a tissue have had a common origin. Improvement in microscopic method has shown that, so far from being independent units, cells are in many cases brought into intimate connection with their neighbours by strands of the living protoplasm passing through the separating wall. Further advance will probably demonstrate such a connection between the cells in all actively living tissues.

The present position may be briefly stated as follows. The unit is a mass of protoplasm in which is embedded a nucleus. Such a unit, or "energid," as it has been termed, is the starting point of every plant; in the lowest forms, development goes no further—as, for instance, in the smaller motile form of the tiny green alga which examination syllabi call *Protococcus*. The first step towards a higher development is the protection of the individual by a cell-wall, *i.e.*, by the secretion round itself of a cellulose membrane formed by and from itself. The resting stage of "Protococcus," or the fertilised egg-cell, the oöspore of higher plants, is an example of such a unicellular individual or phase.

Further development may proceed in two ways. The protoplasmic unit (energid) may grow and divide repeatedly without the separation of the resulting daughter units by partition walls. There is thus produced within a common membrane, which undergoes meanwhile a corresponding increase in size, a large number of nuclei embedded in a general mass of protoplasm. This mode has been adopted in whole groups of Algæ and Fungi; examples are the fresh-water *Vaucheria* and a well-known mould, *Mucor*. Such unseptate individuals, which may reach a considerable size and show a surprising amount of morphological differentiation, as in *Caulerpa*, where a horizontal stem bears roots below and leaves above, are termed "Cœnocytes." The structure in these cases may be strengthened by bars of cellulose stretched across from wall to wall.

Plants like the filamentous green fresh-water alga *Cladophora* illustrate incomplete septation. Each segment of the filament includes within its wall, not one, but a number of "energids." In most cases where the individual attains any size and must provide its own support, as in land-plants, the completely septate form has been adopted. Here the protoplasmic units are each separated (though probably *not* isolated) by a cell-wall. Thus in the great majority of

plants the cell is a very real and useful conception, and regarded merely as a chambering of the protoplasm necessitated by increase in size, differentiation, and need for support, will lead to no misunderstandings.

It is interesting to note that the cœnocytic condition occurs in certain stages in the life-cycle of completely septate plants. The endosperm, or tissue produced in the embryo-sac, which in the gymnosperms is the sexual individual bearing the female organs, is in its first stages non-septate, and though generally becoming completely septate, may remain incompletely so. A similar free cell-formation characterises the early development of the oöspores of the cycads.

THE REIGN OF THE NUCLEUS.

As in general botany and zoology, so also in special cellular histology, modern attention is being more and more concentrated upon the nucleus. It is unnecessary to do more than glance through the illustrations of scientific journals to see that new discoveries and new theories alike refer to the nucleus. In the case of cell-division, the opinion is growing that the changes begin in the nucleus, and that the apparent changes in the protoplasm are due to forces radiated out from changes in the nucleus. The centrosphere, the spindle, and so forth, more and more are being regarded as the visible results of such action of the nucleus upon the protoplasm as a magnet has upon sprinkled iron filings; although, it must be admitted, there are still many observers who interpret the "centrosome" as a special organ of the "cell," and among these, judging from the "Atlas" to which we allude later, Professor E. B. Wilson must be included. In the matter of fertilisation, almost everyone now agrees that what was regarded as a cellular matter is really a nuclear matter. It is the nucleus of the spermatozoon that unites with the nucleus of the egg: and apparently the protoplasm of the body of either the male or female cell is indifferent to the result. As we know, in theoretical questions very great importance formerly given to cells is now transferred to nuclei. Weismann originally spoke of germ-cells: now he speaks of germ-plasma, meaning by that nuclear matter. The continuity of the germ-plasm now for him means, not the existence of a chain of cell-division, of which the successive generations are pendants, but the continuity of nuclear material. Instead of the early separation from the fertilised egg of germinal cells, he speaks of germ-tracks, along which the undisintegrated germ-plasm is handed. In Hertwig's criticism of Weismann, where the question of "heirs-equal" or "heirs-unequal" (NATURAL SCIENCE, vol. v., pp. 132, 184) division occurs, the argument turns upon the nucleus, although the cell, rather than the nucleus, is spoken of.

Adam Sedgwick on the Inadequacy of the Cell-Theory.

So long ago as 1883, when the cell-theory was supreme, Mr. Adam Sedgwick criticised it, and at repeated intervals he has returned to the attack. He took the view that embryonic development was not the formation of cells from a single cell accompanied by co-ordination and modification of these separate units into a harmonious whole. He held that the whole was always co-ordinate and continuous, and that the process of development was "a multiplication of nuclei and a specialisation of tracts and vacuoles in a continuous mass of vacuolated protoplasm." In 1888, in his monograph on the development of *Peripatus*, he insisted that the development did not proceed by the formation of cells. Nuclei multiplied: special tracts were plotted off, and as development proceeded separate cells were marked off. In the *Quarterly Journal of Microscopical Science* (Nov., 1894), he draws conclusions of the same nature from his observation of elasmobranch embryos. The so-called mesenchyme tissue in them is always drawn and usually thought of as a system of branched cells lying between the inner and outer layers, and connected with these only at the points where the mesenchyme is supposed to take origin from the outer layer. Mr. Sedgwick assures us that this is not the case: that the whole young elasmobranch is a continuous mass of pale tissue; on the surfaces the nuclei are arranged in layers, and give an appearance to those on the look-out for epithelia of being distinct epithelia: that the mesenchyme is a net-work of the same fundamental protoplasm, continuous in itself and with the ectoderm and endoderm, and having nuclei at the nodes. Similarly, he asserts that nerves neither grow out as cell-processes from the neural crest to the periphery nor inwards from the periphery. The rival theories are both wrong. It is more correct to say that nerves are simply parts of the continuous ground-substance, which become specialised by the intrusion of nuclei. As it happens, save in the case of the third nerve, the specialisation and entrance of nuclei appear from the centre towards the periphery, from the neural crest outwards. The nerves themselves are developments of the mesoblastic reticulum.

The Nucleus and "its Sphere of Influence."

Mr. Sedgwick, no doubt purposely, couches his attack in strong words, but as our arguments in the preceding paragraphs show, we are not certain that he is a solitary prophet speaking to an unheeding generation. We agree with him thoroughly that many mistakes have been made by the persistence of the original idea that cells have walls, and that embryologists frequently represent areas around nuclei by lines, where these are not clearly marked off, and that they speak and think of the proliferation of cells, when they mean only the proliferation of nuclei. But while the habit has lingered on in drawing, and in many cases in language, in theory and in real interpretation of

the facts, it is nuclei and not cells that seem to most of chief importance. The idea of the continuity of the protoplasm is thoroughly well-established, for plants and for animals, young and old. On the other hand, the idea of units multiplying by division, which used to be attached to the cell, daily receives greater justification as applied to the nucleus. Each nucleus has a sphere of influence, most obvious in the activities of division, but frequently expressed by the formation of cell-walls at the limits of the sphere, or after the shrinking caused by reagents, in lines which may not correspond to definite structures. No doubt, when Mr. Sedgwick's more detailed conceptions are published, it will be plainer whether or no he is inclined to abandon this theory of units, even in its transference to the nucleus. But it seems evident to us that recent work generally, and especially experimental work, supports him in attaching little importance to the frequent division of protoplasm into areas round nuclei, but increasing importance to the presence in so-called multi-cellular organisms of localised foci which multiply by division.

MR. G. C. BOURNE ON THE CELL-THEORY.

THOSE who have been considering Mr. Sedgwick's arguments will naturally turn to Mr. G. C. Bourne's "Criticism on the Cell-Theory" in the *Quarterly Journal of Microscopical Science* (August, 1895). We cannot agree, however, that Mr. Bourne's learned and ingenious essay is much more than dialectic. We differ at the outset from his view that Mr. Sedgwick is vague or that "the phenomena to which he draws our attention have received their due meed of recognition from the time that the cellular structure of tissues was first studied." As we have already shown, we think that Mr. Sedgwick has exaggerated the results of the devotion given by zoologists to the cell-theory. On the other hand, it is quite true that in drawings of embryonic and adult tissues, zoologists habitually in the last ten years have represented by sharp lines the boundaries between cells, and so have given to the separation of the protoplasm of cells an importance that is a matter of theory rather than of observation. Recognition of the existence of multinucleate Protozoa, and of organisms like myxomycetes and *Botrydium*, and of the continuity of the protoplasm through cell-walls, is not Mr. Sedgwick's point. The side of embryonic development that has been most prominent in zoological writing and teaching has been the multiplication and marshalling of cells: the side of histology that has been most prominent is the presence of cellular units in tissues. It has been recognised on all hands that the cells in embryonic and adult tissues are distinct from each other in varying degrees; but the fundamental idea has been that cells consisting of protoplasm and nucleus are the unit masses. Against this Mr. Sedgwick urges the totally distinct conception that while nuclei are discrete unit masses

multiplying by division, the protoplasm in which these lie is typically a continuous mass increasing by continuous growth. Mr. Bourne lays great stress on recent and beautiful work upon cell-lineage in development. But in most of these cases what has been proved is *nuclear* lineage. Hertwig, experimenting with the frog, showed that nuclei could assume different positions in the general mass of protoplasm under different conditions of development, and we doubt if even the apparent migrations of cells in the development of *Nereis* necessarily imply more than migration of nuclei. In drawing an argument for the cell-theory from the definite places assigned "cells" in development, Bourne seems to us to have overlooked the experiments of Wilson, Driesch, and Hertwig, who have shown that the nuclei may be moved about in the protoplasmic mass almost as freely as "a heap of billiard balls may roll over each other."

E. B. Wilson's Atlas of Fertilisation and Karyokinesis.

As we have been discussiug the cell, we may refer here to a beautiful Atlas of Fertilisation and Karyokinesis of the Ovum, recently published (price $4 = sixteen shillings), by Macmillan & Co.'s American house, for the Columbia University Press. It consists of ten plates, each containing four photo-micrographs of stages in the cell-division and fertilisation of the sea-urchin, *Toxopneustes variegatus*. The letterpress, in addition to descriptions of the plates, contains a full account of the maturation and fertilisation of eggs, illustrated by drawings partly from preparations of *Toxopneustes* and partly from other material. The photographic technique was conducted by Mr. Edward Leaming at the Columbia University College of Physicians and Surgeons, while Professor Wilson prepared the sections and preparations, and focussed the apparatus upon the requisite objects. Every biologist owes the greatest gratitude to the authors and publishers of this beautiful volume: and only those who have laboured themselves to make good photographic plates from specimens exhibiting karyokinesis can appreciate the wonderful delicacy of the results. The eggs were "fixed" with a mixture of concentrated aqueous solution of corrosive sublimate (80 per cent.) and glacial acetic acid (20 per cent.); and they were stained on the slide with Heidenhain's iron-hæmatoxylin.

It is unnecessary to refer at length to details which every histologist will wish to see himself, and which are too technical for those who are not specialists in histology. Among points of more general interest, we may mention that Professor Wilson accepts the view that a definite number of chromosomes are present in the nucleus of each species. When an egg is preparing to throw off polar bodies, a large part of the chromatin disappears into the "linin" or nucleo-plasm, while the remainder appears in half the number of chromosomes normal in the cells of the tissue. Each of these chromosomes is arranged as a tetrad, and when the first polar body

is given off each tetrad divides into an extruded and a retained dyad. For the second polar body, each of the retained dyads divides, and three chromosomes are extruded, three retained, each being a quarter of the original tetrad. It is clear that the distinction between reducing divisions and ordinary divisions suggested by Professor Weismann cannot be applied to the formation of the polar bodies as interpreted by Professor Wilson. Another interesting general point, very plainly illustrated in these photo-micrographs, refers to the early stages in polyspermy. In *Toxopneustes* two spermatozoa may enter the egg simultaneously. An aster is formed around each, and they move equally towards the nucleus of the egg-cell. When they reach it, each aster divides, and there is formed a "quadrille" figure, consisting of the egg-nucleus found with the two sperm-nuclei, and surrounded by four asters at equal distances. The joint nucleus then divides, so that four daughter-nuclei are formed. Professor Wilson thinks, and his figures bear him out, that when Fol originally described the "quadrille" figure, he was dealing with an abnormal occurrence of this kind.

FOSSIL CELLS.

IT is plain that, though the hard cell-walls of extinct plants may leave evidence behind them, as indeed they do in abundance, it is very unlikely that there should be fossil evidence of animal cells. However, in some cases, it happens that such evidence does exist, and as it may not be known to many of our readers, we give it. The earliest known remains of the skeleton of chordate animals, which may have been either fishes or something lower, are fragments of dermal armour from the Silurian Formation. Their microscopical structure is often beautifully preserved, and can be examined almost as readily as the tissue of an existing animal. The simplest of these fossils are thus proved to be mere granules of "shagreen," each formed round a little papilla and nourished by radiating, branching capillary tubules. The soft papilla is never fossilised, always replaced by rocky matrix; but, judging by analogy with modern sharks, it must have been furnished with the little formative cells termed "odontoblasts." Sometimes these tubercles are fused together into continuous plates; and among Devonian fossils instances are already common in which a great basal layer of hard tissue is developed, leaving the original tubercles as a simple pustulate ornament on the exterior. The secondary basal layer is often provided with little spaces, which must have been occupied by cells similar to those of modern bone; but in very many—perhaps in the majority of cases—the tissue consists of parallel or concentric layers conforming with the outer surface, and not traversed by any passages analogous to the haversian canals of true bone. Such skeletal tissue is named "isopedin." Typical bone, however, is also found in some dermal armour even of Devonian age.

Another form of dermal skeleton of the Upper Silurian and

Devonian periods, but apparently never represented later, is that of the singular group of Pteraspidians (*see* NATURAL SCIENCE, October, 1892). The greater part of the thickness of the plates of these organisms is formed by delicate structureless lamellæ or laminæ, concentric with the exposed faces, exhibiting no minute cavities for protoplasm-cells, but surrounding and enclosing great vascular spaces. The outer layer alone consists of ridges, through which delicate capillary canals radiate from a central soft tissue of which no trace is fossilised.

RECONSTRUCTIONS FROM SERIES OF SECTIONS.

AN elaborate and technical paper by Mr. H. B. Pollard (published in the eighth volume of Spengel's *Zoologische Jahrbücher*) contains the results of work based upon a method little practised or, indeed, known in England, though long since described in NATURAL SCIENCE.[1] Mr. Pollard has been investigating the anatomy and development of the head in siluroids and other fishes, for some years, and he has now perfected, at the Owens College, the method of Born which he learned in Germany. When a complex structure like the head of a young fish has to be investigated by means of series of sections, it is, as everyone knows who has worked with continuous series, very difficult to construct from the consecutive drawings a solid image in the mind. Mr. Pollard built up models in the following way: The heads of the young fish were decalcified, and double-stained with alum carmine and bleu de lyon. They were then cut in a series, each section being of known thickness. Next, drawings of the sections were made with a camera, and the drawings were transferred to plates of wax. The thickness of each plate was carefully made the same multiple of the thickness of the section that the camera drawing was of the area of the section. The plates of wax were then cut out following the drawing, so that a series of wax representations of the series of sections was obtained. These were too large and too brittle to be handled conveniently, and the special improvement of Mr. Pollard upon Born's method was that he electroplated his wax slices. The plated slices were then fixed together in their order, and the resulting model was, within slight limits of error, a faithful copy of the original head. In his paper Mr. Pollard gives a number of drawings from the models.

THE HEART IN BIRDS AND REPTILES.

IN a recent number of the *Proceedings of the Zoological Society* (part iii., 1895), Messrs. F. E. Beddard and Chalmers Mitchell describe the heart of the alligator, giving a number of useful figures. They refer at some length to the interesting morphological question of the homology of the valve in the right ventricle of the bird's heart.

[1] Vol. iii., p. 340, in "Natural Science at the Chicago Exhibition."

Since Professor Lankester's memoir on the subject, it has been accepted generally that the entire avian valve corresponds to one-half only of the complete valve of the crocodile and of the mammal. The valve is attached by a muscular bridge to the wall of the heart, and this point of attachment divides it into a long fleshy flap on the right side, and a membranous, shorter flap on the septal side. Messrs. Beddard and Chalmers Mitchell regard the septal flap as a valve corresponding to the septal valve of the alligator: its anatomical relations are identical with those of the alligator's septal valve, and in several birds they have found a considerable portion of muscle present in it.

The Anatomy of Chauna.

To the same number of the *Proceedings* Mr. Chalmers Mitchell contributes a detailed paper on the anatomy of the Crested Screamer. It is, no doubt, becoming more and more certain that the value of investigations in vertebrate anatomy is comparatively small until a large number of individuals in each species has been examined; but in the meantime a detailed examination of a comparatively rare and isolated form like a screamer has a considerable value. Of the three species of screamers known, Garrod has written an account of the anatomy of *Palamedea;* Beddard and Mitchell of that of *Chauna derbiana*, and Mr. Mitchell now compares *C. chavaria* with the others. To anatomists in general, the most interesting part of his paper will be the comparison he makes between the alimentary canals in the ostrich, in the crested screamer, and in the Anatidæ. In all three, the dispositions of the intestine are comparatively simple, and are not much modified from a primitive straight gut, but of the three the screamer is least modified. Dr. Gadow has already made a memorable contribution to knowledge of the alimentary canal in his series of papers upon the taxonomic value of the intestinal convolutions, but it is evident that the subject is yet far from exhaustion.

An Autograph Portrait of Huxley.

Mr. Thomas Whitelegge, of the Australian Museum, Sydney, has been so kind as to write to us as follows: "I read with great interest the account in your August number of the late Professor T. H. Huxley; the portrait was especially interesting. I send you a copy of a sketch drawn by himself when in Sydney in 1848, which I think you will admit is a capital likeness if compared with the one you publish. . . . The original sketch is on the fly-leaf of a book, 'The Pilgrims of the Rhine' (Lytton), and is now in the possession of Mrs. Deane, of 'Waimea,' Woollahra, Sydney." From a note on this drawing contributed by Mr. Charles Hedley to the Australasian edition of the *Review of Reviews*, we extract the following remarks: "Before he became a celebrity, the late Professor Huxley visited Australia in the capacity of surgeon to H.M.S. 'Rattlesnake.' Not

only did this cruise exercise its influence upon his intellectual life, but as he met his future wife in the person of a Sydney lady it was also eventful in his domestic history. . . . Upon her birthday Huxley presented the little daughter of a friend with a volume of Lytton's poems, and sketched upon the title-page a drawing of himself.

Dressed in the shoes, knee-breeches, and frock coat of the period, he seems to be bowing his departure. In his extended right hand a watch is held, to show that time will not permit him to linger another minute. By those who knew him in later years the face is said to be a capital likeness."

We may take this opportunity of quoting the following lines which form the epitaph on Huxley's tombstone:

> "And if there be no meeting past the grave,
> If all is darkness, silence, yet 'tis rest.
> Be not afraid, ye waiting hearts that weep
> For God 'still giveth His beloved sleep.'
> And if an endless sleep He wills, so best "

These touching words were written by Mrs. Huxley, and, according to the *British Medical Journal*, were used at Huxley's own request.

The *Athenæum* informs us that a difference has arisen among the members of the Huxley Memorial Committee as to whether the memorial should take the form of a statue or of a scholarship. Our

esteemed contemporary votes in favour of the statue, remarking that there are scholarships enough already. We do not wish to disagree with so respected a journal, but in favour of the scholarship we, in our turn, might say, "There are statues enough already."

STIPULES.

AN addition to the literature of stipules—the well-known basal appendages of the leaf-stalk—will be found in the last number of the Linnean Society's *Journal* (vol. xxx., pp. 463–532), where Sir John Lubbock describes the form and discusses the function of these structures in a large number of plants. Young leaves, still enclosed in the bud, are extremely susceptible to cold and drought, and also afford tempting food to insects and other animals. It is, therefore, not surprising to find that the most general purpose served by the stipules is bud-protection. In many cases they fall after the unfolding of the leaf—as in the lime—where the pinky-white scales litter the ground beneath the tree. Often they are persistent, and supply one of the most constant characteristics of a whole family, as in the Rubiaceæ, in the British representatives of which it is difficult to distinguish stipules and leaves. Sir John has a few interesting cases in this connection. In a species of pepper (*Piper longum*) the pair of stipules of the youngest unfolded leaf covers the terminal bud with a sort of nightcap, the stalk of the same leaf appearing continuous with the main axis. A similar arrangement occurs in the magnolias. In *Alstonia scholaris*, belonging to the Apocynaceæ, the leaves form a whorl at the tip of each season's growth, while a triangular outgrowth or ligule from the base of the upper surface of each converges towards one centre, thus covering all but the extreme apex of the terminal bud. This ligule is doubtless a stipular structure. In *Buddleia* (Loganiaceæ), on the contrary, the deeply-channelled petioles with their dilated base protect the axillary buds so well that stipules are dispensed with in the early stages of the leaves, and develop only as these gradually attain their full size. An exstipulate rose is an anomaly: such, however, is *Rosa simplicifolia*, where the petiole has only a thin margin continuous with the blade and dilated at the base to protect the bud in its axil. It is stated, on the authority of Dr. Masters, that the vascular bundle intended for the stipules still exists, "indicating that they existed formerly."

In *Nymphæa tuberosa*, an ally of our water-lily, the stipules are 2–3½ centimetres long, and with the decaying remains of old leaves form a covering to the dense, compact, submerged, winter bud, protecting the tender young leaves "from fishes and other aquatic animals that feed on vegetation."

Stipules of two or more kinds are sometimes found in the same plant. In *Catha edulis* (Celastrineæ), besides the true, narrow-pointed, ciliate, erect stipules, there is a second set consisting of "coarse

fringes or cilia, not unlike the Tamenta of ferns," in front of the petioles and true stipules. When the latter fall, the plant appears to possess only these fringes. In a member of an allied family—*Paliurus australis* (Rhamnaceæ)—they are again dimorphic, but here spiny in both cases, serving two purposes. On the strong, upright, young stems they are largest and longest, being slightly decurved, and nearly equal in size. On the slenderer lateral shoots they are very unequal and dissimilar. Those on the upper side of the branches are longer, long-pointed, and straight, and arranged in two ranks, one to the right, the other to the left of the shoot. On the lower face, they are short and decurved, or hooked. It is suggested that, while the straight ones serve to protect the plant from browsing animals, the hooked ones will, in addition, help it to climb or scramble among the bushes or shrubs. The enlargement of some of the stipules in certain acacias to form great horn-like structures, which are generally hollow with a small opening, and, in America at least, usually tenanted by colonies of stinging ants, is an interesting and often-cited case in myrmecophily. Similarly, the greatly enlarged leaf-sheath turned up at the edges, in some species of *Smilax*, forms a pocket, in which, as Burck has already pointed out, ants come to live. Burck, however, believes this development to be quite independent of the necessity for bud-protection, and merely the result of the benefit accruing to the plant from the presence of the ants. The base of the petiole in *Korthalsia*, a rattan palm, is developed into a large hollow ocrea (or sheath) which ants use as a home. In this case, at any rate, it is impossible to conceive of any benefit resulting to the plant.

Apart from certain cases of biological importance akin to those cited above, Sir John's paper is useful in pointing out the existence of stipules in exceptional cases, or in genera and species in which they have hitherto been undescribed.

African Orchids.

If the plants brought home by Mr. Scott Elliot from his recent trip to Central Africa and Mt. Ruwenzori prove as interesting throughout as the orchids and asclepiads have done, he is much to be congratulated on the results of his expedition. The October number of the *Journal of Botany* contains the conclusion of an account of the orchids by Mr. Rendle and the first part of a description of the asclepiads by Mr. R. Schlechter. Among other novelties in the latter family we notice a new genus, while of the orchids a large percentage have been hitherto unknown to botanists. Most of these belong to typical tropical African genera like *Lissochilus*, *Eulophia*, *Angræcum*, *Polystachya*, *Habenaria* and the like, but in one case Mr. Elliot's plant gives a widely extended area to its genus. *Epipactis* (helleborine) is a name well known to British botanists, and by the discovery of a new species (*E. africana*) at 8,000 to 10,000 feet on Mt. Ruwenzori, the

genus hitherto known only from the north of the continent has its range extended into the heart of tropical Africa. The new species closely resembles our native *Epipactis latifolia* in its stem and leaves, but has larger flowers.

NORTH AMERICAN DELTOID MOTHS.

DR. J. B. SMITH has just issued (*U. S. Nat. Museum Bulletin*, 48) another of his valuable memoirs on the moth-fauna of Boreal North America, containing the group of noctuids generally known as Deltoidea—the snout-moths and their allies. The work comprises a discussion of the limits of the section, with special reference to structural characters, followed by tables, and descriptions of the genera and species, including a full synonymy. There are nine photographic plates to illustrate the species described; in the majority of figures the characters are clearly brought out by the process employed. We also notice with pleasure the five plates which show the structural characters of the various genera. Among the deltoid moths, the males are often provided with complex and mysterious sense-organs on the feelers and legs. That attention is drawn to such structures, as is done by Dr. Smith's figures, is a welcome contrast to the neglect of everything but the wing-patterns, which too often characterises the work of systematic writers on the Lepidoptera.

DISPERSAL OF MARINE ANIMALS BY SEAWEEDS.

MR. RUPERT VALLENTIN (*Annals and Magazine of Natural History*, Nov., 1895), gives the results of many interesting observations he has made upon the dispersal of marine animals. His attention was attracted to the subject by finding, three miles south of Falmouth Harbour, a mass of *Fucus serratus* floating in the ebbing tide. To its base was attached a large stone, and numerous hydroids and bryozoans were carried as passengers. Many of the common seaweeds float for considerable periods, *Fucus nodosus*, for instance, for eleven and a half weeks, and, therefore, with favourable winds and surface currents, seaweeds and the animals upon them could travel enormous distances. He has found *Cardium edule* and the common mussel attached to floating weeds, as well as masses of the ova of *Aplysia*, while many annelids and hydroids are quite common. It is clear, then, that, in addition to dispersal by free-swimming larvæ, a number of littoral and bottom-forms may spread by this passive agency; as the large weeds of the Laminarian zone are frequently uprooted during storms. We have always thought that the delicate, short-lived pelagic stages of many annelids and molluscs were given too great an importance from the point of view of dispersal, and Mr. Vallentin's observations help to explain many difficult cases.

I.

Ocean Deposits, Ancient and Modern.

II.—The Mollusca.

OF the various forms of animal life abounding off our shores, the most wide-spread, as also the most important, are the Mollusca; and their general distribution having been well determined, it is possible to compare their extension in our day with their extension in the older stratified deposits. Returning, therefore, to the type more specially selected for comparative purposes in this discussion, viz., the Upper Cretaceous period, several questions at once present themselves for solution, and may now be taken in order.

1. Was the molluscan fauna of that period, in its main features, similar to that existing at the present day?

Although, owing to the lapse of time since the Chalk was deposited, specific resemblance may be impossible, yet should generic identity and more especially a marked similarity in the grouping of the forms be admitted, then such facts must become of the greatest interest. To determine what the prevalent fauna of the period was, it is necessary to seek areas which are generally allowed to have been free from the influences which led to the formation of the true Chalk deposits. Such areas are situated in southern and south-western Germany, comprising the Cretaceous deposits of Bohemia, Saxony, the Hartz, and Westphalia. Here existed a molluscan fauna resembling in all its main features that fauna of the present day which occurs in decidedly subtropical regions.

Although most of our leading text-books represent the appearance of many Gastropoda—especially of such carnivorous forms as *Voluta* and *Fasciolaria*, in the Maestricht Chalk and Faxe Limestones—as novel and startling, and peculiarly foreshadowing the advent of the Tertiary period, yet these genera seem to have existed throughout all Upper Cretaceous time, on the borders of the South German continental area. *Voluta*, *Conus*, *Strombus*, *Turritella*, *Trochus*, and *Fusus*, as also *Cerithium*, *Natica*, and *Buccinum*, are by no means uncommon in the strata of Bohemia and Saxony, and had a very wide extension during the period which corresponds to that of our Upper Chalk. Nor are these the only localities where such an assemblage has been met with. In New Jersey, Clark and Williams have shown the presence

of no less than 282 species of Mollusca, of which 45 per cent. are Gastropoda. Also in the Blackdown Hills, at the base of our own Upper Cretaceous series, univalves play a most important part, but with marked changes of genera, forcing upon us the conclusion that even before the Cretaceous period minor faunal provinces were clearly marked out. Of the forms here present, *Turbo* is prominent, *Solarium*, *Natica*, and *Littorina* are important, while *Voluta*, *Conus*, *Strombus*, *Mitra*, and *Phorus* are entirely absent. We are thus led to the suggestion that the conditions in our own region were probably of a more temperate character than were those which prevailed further to the south on the Austro-Saxon frontier. The answer to our first question appears to be that the principal genera of univalve Mollusca in Cretaceous times were identical with those of the present day. The variations observed in their distribution are probably due to the difference of temperature and surrounding conditions, while their specific richness indicates that theirs was no new appearance, but a direct continuity, obeying laws which research and comparison may lead us to determine more fully in the future.

Exclusive of molluscan genera now extinct, such as *Inoceramus* and *Gervillia*, I have been able to obtain the record from Germany and England of thirty-three genera of Gastropoda embracing no less than 171 species; and of bivalves (Pelecypoda) forty-eight genera with close upon 300 species.

For the extension of the Mollusca in the German Cretaceous, one may refer to Geinitz, "Quadersandsteingebirge in Deutschland" (1849–50), and F. A. Roemer, "Die Versteinerungen des Norddeutschen Kreidegebirges" (1840), in both of which are to be found useful tables indicating clearly the genera, the number of species, and their general distribution in the Upper Cretaceous strata of Germany.

2. In natural sequence to the above we are now led to inquire whether at the present day any particular distribution is to be observed in the Gastropoda on the one hand, and the Pelecypoda (Lamellibranchia) on the other, more especially in connection with their bathymetric extension.

The records of the "Challenger" Expedition reveal the fact that the Gastropoda rapidly diminish both in number and specific richness as greater depths are approached, only comparatively few of their genera having been met with beyond a limit of 500 fathoms. Thus, of the genera known as occurring in the Upper Cretaceous, twelve only have been found at depths exceeding 300 fathoms. Five only appear to be of a decidedly ubiquitous character, viz., *Trochus*, *Actæon*, *Pleurotoma*, the Scaphopod *Dentalium*, and more rarely *Natica*. At a depth of over a thousand fathoms *Fusus*, *Scalaria*, *Eulima*, *Murex*, and *Aporrhais* have each been once met with, these same genera, together with *Solarium* and *Turbo*, being more abundant between 300 and 1,000 fathoms.

An examination of the records of the Lamellibranchiate genera

known from the Upper Cretaceous, and still existing, shows that but few extend beyond the 1,000-fathom line, yet at these considerable depths *Arca* has been found 7 times, *Lima* 4, *Lyonsia* 3, *Leda* 2, *Nucula* 2, *Pecten* 2, *Pectunculus* 1, *Venus* 1, *Teredo* 1, and *Modiola* 1. At a range not exceeding 600, but deeper than 300 fathoms, *Anomia*, *Lucina*, *Tellina*, and *Cardium* have also been obtained. The fine-shelled forms, such as *Neæra* and *Callocardia*, are decidedly deep-sea in their characters; but should they have existed during Cretaceous time, it is more than probable that, owing to the delicacy of their tests, they would not have been preserved.

3. What is the character of the distribution of the Mollusca in Cretaceous times, and is there any general resemblance to the sequences above noted?

We have in Germany two regions serving as a basis for comparison with modern conditions: the shore-line of the South German Continent on the one hand, and on the other the Rügen Chalk, which must have occupied a fairly central position in the Chalk Ocean. Taking for the purpose of analysis those strata of the first area which correspond in age to our Upper Chalk, we find the Gastropoda represented by ninety-six species, the principal genera having the following specific development: 13 species of *Fusus*, 12 of *Trochus*, 11 of *Rostellaria*, 8 of *Turritella*, 7 of *Cerithium*, 6 of *Voluta*, 6 of *Dentalium*, 4 of *Acmæa*, and 4 of *Strombus*. Similarly, the Pelecypoda are represented by 186 species, distributed as follows among the predominant genera: *Pecten* 30, *Arca* 16, *Lima* and *Venus* each 13, *Inoceramus* 12, *Nucula* 10, *Avicula* and *Cardium* each 8, *Mytilus* 7, *Corbula* and *Pholadomya* each 6, *Cardita* and *Pectunculus* each 5 species.

In favour of the idea that the Chalk of Rügen was deposited in far deeper seas than the above, there is the following evidence: in it are found only 2 genera of Gastropoda, viz., *Trochus* 1 species, and *Nerita* 1 species; 2 species of Dimyaria, both *Arca*; 19 species of Monomyaria distributed between the ubiquitous genera *Inoceramus*, *Pecten*, and *Lima*; also 1 species of *Gervillia*, which, commencing in the lowest beds of the Upper Cretaceous and continuing to the highest, has not only a wide range in time, but also an extended one in area, occurring, as it does, in Bohemia, Saxony, Schleswig, the Hartz, and Aix-la-Chapelle. It is surely significant that every one of the comparable genera found at Rügen is of a type known to exist in modern seas at a depth of over 1,000 fathoms, and that all the littoral forms so abundant on the shore-line of the South German continent should have absolutely and entirely disappeared.

Again, from a geographical point of view, some marked distinctions are to be observed. Leaving the Aix-la-Chapelle deposits out of account, we find that of twenty-four Gastropod genera a gradual variation takes place; 18 occur in Bohemia, 13 in Westphalia, 10 in Schleswig, and 6 in the Hartz. On the other hand, the Dimyaria take almost an exactly opposite course, there being 21 in the Hartz, 20

in Schleswig, 16 in Bohemia, and 10 in Westphalia. Combining, therefore, this evidence with the changes in the lithological character of the Upper Cretaceous rocks, viz., the more sandy condition of the strata in Bohemia and Saxony, and their more calcareous character in Schleswig and Rügen; and taking into account the far greater richness of the echinoderm fauna in the northern provinces of Germany, it should be conceded that the Mollusca displayed a definite arrangement and grouping in Cretaceous times, the Gastropoda being richer in species nearer shore, the Dimyaria becoming more abundant in depths beyond the littoral boundaries, while in the deep sea Monomyaria were decisively predominant.

We are consequently led to the conclusion that in Upper Cretaceous times the continental shore-lines and oceanic areas had a molluscan fauna subject to laws of distribution like those of the present day; and that the Gastropoda, Scaphopoda, and Pelecypoda occurring in the white chalk of northern Germany belong to genera which at the present day range in depth up to or over a thousand fathoms.

The preceding discussion has chiefly dealt with beds occurring in Germany, all deposited at the same period, but under dissimilar conditions. Let us now turn to England and trace the change in the molluscan fauna, not in space, but in time, and mark the variation displayed during the changing conditions at the close of the Cretaceous period.

Evidence is by no means wanting of the existence of a very rich molluscan fauna at the beginning of the Upper Cretaceous period, and this has already been referred to in the mention of the Blackdown deposits. For the sake of comparison with the German data, a list, based on a personal study of our national collections, may be given. Gastropoda, 25 species: the principal genera are *Turbo* 4, *Natica*, *Littorina*, *Aporrhais*, and *Fusus* 3 each, *Turritella* and *Rostellaria* 2 each, other genera being *Murex* and *Dentalium*. Pelecypoda, 64 species: the principal genera are *Trigonia* 12, *Cytherea* 7, *Nucula*, *Astarte*, and *Exogyra* 4 each, *Cyprina*, *Cardium*, *Cucullæa*, and *Mytilus* 3 each. For the same period in Germany the principal types were: Gastropoda; *Trochus* 10, *Rostellaria* 6, *Turritella* and *Pleurotomaria* 3 each, but the tropical forms, *Voluta*, *Conus*, and *Strombus*, were already sparsely represented: Pelecypoda; *Pecten* 18, *Lima*, *Arca*, and *Mytilus* 8 each, *Inoceramus* 5, *Gastrochæna*, *Cardium*, *Cyprina*, *Nucula*, and *Avicula* 3 each. It appears to follow from these data that the minor life-provinces of the Mollusca were already well marked out; the result of subsequent changes was on the one hand, to accentuate the tropical character and increase the specific richness of the German fauna, and on the other to reduce the molluscan variety in the English area.

In the higher strata of the Upper Greensand of England the change becomes well marked. *Pleurotomaria* now takes the lead among

the Gastropoda with three species, *Aporrhais* having two only, and the remainder but one each, a remarkable reduction when compared with Blackdown conditions. The area from which these data have been taken is in no sense restricted in its character, embracing, as it does, the Upper Greensand of Warminster, Devizes, Cambridge, and the Isle of Wight. This conclusion is confirmed by various memoirs of the Geological Survey, and Westlake's analysis of Barrois' results, which take into account the Norwich district and the whole of the London Basin. Among Pelecypoda, the foreshadowing of the predominance of Monomyaria is already marked. In the Isle of Wight, *Ostrea* is represented by 10, *Pecten* by 3 species, whereas *Trigonia* has only 5; *Lima*, *Plicatula*, and *Spondylus*, with 3 species each, have as principal Dimyarian competitors *Panopæa* and *Cucullæa*, also with 3 species each. At Devizes the same facts hold good, *Pecten*, *Lima*, and *Inoceramus* having each three species, *Modiola* alone among Dimyaria being represented by an equal number. On reaching the Chalk Marl the distribution becomes exceedingly simple in its character, and in only one county, viz., Sussex, more especially at Hamsey, near Lewes, has any important combination of genera been met with. This combination, however, is one of the highest interest, and is, in fact, startling in its nature, for at this spot, and nowhere else, we find suddenly revealed groupings of *Trochus*, our only *Voluta*, *Buccinum*, *Cerithium*, *Turritella*, *Turbo*, *Solarium*, *Aporrhais*, *Pholadomya*, and *Dentalium*, the last three also having been met with together at Dover or Folkestone. It is most remarkable that so many tropical or subtropical forms should be found at this one spot. Lewes is one of the richest neighbourhoods for Cretaceous fossils, and I have suggested that this and other features may have been due to the presence of a great current at this locality. It is also evident from the nature of the fauna that this current must have been a warm one, possibly flowing from the east, and deflected northwards by land areas in the region of our western counties. With this sole exception the rule I have formulated seems to be constant; the Monomyarian fauna is decidedly predominant, *Lima* and *Ostrea* having 6 species each, *Pecten* 5, and *Janira* 3. Further details can be gathered from the Survey memoirs, Barrois' work, and the collection in the Natural History Museum.

From the *Belemnitella plena* zone (at the base of the Middle Chalk) upwards, the Gastropoda and Dimyaria lose their importance. *Inoceramus*, *Lima*, *Pecten*, *Spondylus*, *Plicatula*, and *Avicula* are, as is well known, the only genera common in the zones of the Middle Chalk, and by no means rare in those of the Upper Chalk. Other finds should be considered casual, in no way invalidating the conclusion as to the deep-sea nature of the deposit. A large specimen of *Pleurotomaria* seen by me at Lewes, which had been obtained from the *Marsupites* zone, and the *Pinna* from the Upper Chalk at Bromley, created in my own mind for some time a real difficulty, which was,

however, removed after reading the "Challenger" Report on the Lamellibranchiata (vol. xiii., p. 5), in which Mr. E. A. Smith, referring to deep-sea forms, says: "We might multiply examples of the different ranges in depth at which various species have been obtained by the 'Challenger' and other expeditions, but those which have been cited are sufficient to show that the same species is equally well adapted for living in deep or shallow water, and, as far as our observations have reached, the shells appear to be very little affected by the difference of the depth or the nature of the bottom." This opinion was all the more gratifying as it fully confirmed the conclusions I had based on my own studies of the Cretaceous faunal distribution.

Attention must now be drawn to two exceptions to the rule here laid down, which demand more extended consideration. Lithological evidence points to the close of the Middle Chalk period as having been a time of change, probably in the direction of reëlevation. The palæontological facts seem peculiarly striking in this respect. *Holaster*, of which *H. subglobosus* was the highest of the Grey Chalk Marl species, now reappears in the Chalk Rock as *Holaster planus*. Ammonites and scaphites, which were last met with in abundance in the Grey Chalk, return in the Chalk Rock of Oxfordshire as the species *Pachydiscus prosperianus* and *Scaphites geinitzi*. The arenaceous Foraminifera, the abundant quartz grains from the residues, the crystals of tourmaline, were all left behind in the Grey Chalk, but again we find them appearing in the Chalk Rock. Is there no lesson, no significance in this? To me it seems clearly to indicate that the distribution of the animal forms is in the main independent of the character of the sea-bottom, and is far more influenced by temperature as a direct result of depth, and by the strength of the prevailing currents. Here, then, we see the principle of colonies supported by historical data. Time has produced some alteration in the species, but genera reappear which apparently had disappeared from the stage of Cretaceous history, these belonging to the most varied groups, and identical with those that existed throughout the whole of the Lower Chalk period. If this be so with the Cephalopoda, should we not expect that, in some measure at least, the other Mollusca would also be affected? Here, too, the results are of a character to convince the most sceptical. *Turbo gemmatus*, and forms of *Trochus* and *Solarium*, again resume their place among the important fossils of this series. The trochoid forms are the last to disappear during depression, and they are also the first to reappear during elevation, and should my theory be accepted as having a firm and logical basis, it would no longer be necessary to go to lithological characters to learn whether elevation or depression had taken place, since the fossils themselves would clearly establish the physical changes of the period.

At the close of the Upper Cretaceous period, a remarkable group—rare, it is true, but preserved in our great national collection—claims

our attention. In the upper portion of the *Belemnitella mucronata* zone at Norwich the following forms have been met with: *Emarginulina*, *Corbula*, *Chama*, *Nucula*, and *Dentalium*. The appearance of these seems to have been the first sign of that change which was about to close the Cretaceous period, and the first indication of that reëlevation which was to alter the whole character of palæontological history. This single gastropod, the scaphopod, and these few dimyarian bivalves seem already to suggest the great alteration in physical conditions which was about to supervene. To these must also be added the large *Terebratula obesa*, which occurs both in the Warminster Upper Greensand and the Upper Chalk of Norwich.

A comparison of the general relations of the molluscan sequence in the past with that existing at the present day seems to establish a certain resemblance and parallelism which should receive the fullest attention from the student of Cretaceous history, and the following facts seem worthy of consideration. The character of the genera from the South German strata, as also of those from the Blackdown Hills, is that of a fauna now living at a depth of less than 30 fathoms. The depression producing the Upper Greensand formation caused the disappearance of many gastropod and dimyarian genera, the survivors being similar to those now existing beyond the 30-fathom line. The predominance in the Lower Chalk of such Monomyaria as *Pecten* and *Lima* is evidence of a depth exceeding 300 fathoms; and this is confirmed by other evidence (see *Proc. Geol. Assoc.*, May, 1894). From the Middle Chalk period onward are to be found only these ubiquitous types, and those of extinct monomyarian genera; but the presence of *Trochus*, *Turbo*, and *Solarium* in the Chalk Rock is paralleled at the present day by the same association found at Culebra Island at a depth of 390 fathoms. Referring to the fact, already noted, that the Mollusca of the Upper Chalk are of the same types as those which at the present day extend their range to the greater oceanic depths, and that the faunal characters are so closely paralleled by those of the oceans of the present day, I would submit that the Chalk Sea was a true oceanic depression, and would use this as an argument against the permanence of oceanic basins (see my "Genesis of the Chalk," p. 227).

Although after careful study it seems evident that those genera which are present in both the Chalk and the now existing oceans have the same character of distribution, it must be admitted that many types of the present day having a wide bathymetrical range had no representatives in Cretaceous times. *Pleurotoma* is a form of the widest distribution in depths exceeding 1,000 fathoms, yet no traces of it are to be found in the chalks and marls of the Upper Cretaceous period. Among the deep-sea Pelecypoda, *Neæra*, *Callocardia*, and *Cryptodon* are most abundant, yet neither in this nor in any other land has the Chalk formation yielded a single specimen. Their absence may be due to either of two reasons: one, that the shell-structure is of so delicate a

nature that it has been unable to resist disintegrating influences, and the other, that these genera were non-existent during that period. The first hypothesis may account for the absence of these Pelecypoda, owing to the fragility and delicacy of their tests; the last, however, cannot hold good in the case of *Pleurotoma*, seeing that its specific development during the Tertiary period was so rich and varied that it would be strange if it had not already been well established in Cretaceous times.

Closer examination into the distribution of the Mollusca reveals facts of the highest scientific interest, not only tending to prove that even in Cretaceous times their life-provinces were well marked and defined, but also giving evidence of the individual migration of species and of the gradual northern advance of whole groups. It seems beyond doubt, from study of the Upper Cretaceous of southern Germany, that the carnivorous Mollusca, such as *Voluta* and *Conus*, genera so characteristic of the present tropical and southern seas, had at the early part of that period obtained but a slight footing. But in Upper Chalk times they form a striking feature, being rich in species and widely distributed along the shores of the old Cretaceous continent. It is a remarkable fact that, notwithstanding the varied character of these occurrences in Germany, none of these genera had been able to migrate either to Great Britain or France, the reason evidently being that the great depression had proved an effectual barrier to their advance, whether westward or northward. Only when the elevation that closed the Cretaceous period had begun was this barrier removed, and how suitable were the climatic conditions for their extension at that time is evident from the great variety and specific richness of these genera in the Tertiary strata.

It may not unjustly be advanced that a discussion of this kind should deal, not only with genera and species, but likewise with the size and abundance of individuals. On these points, while fully recognising their great importance, I regret that I have been unable to obtain any really reliable and definite information as regards the German fauna, though what I have gathered tends to confirm my views; indeed, the very wide distribution of so many species, both of Gastropoda and Pelecypoda, especially in the more southern districts, renders it in the highest degree probable that the molluscan fauna was rich, not only in species, but also in individuals, though not comparable in this respect with the subsequent Tertiary fauna.

A recent examination of the series of forms from the Blackdown beds which is preserved in our national collection, has confirmed my conclusions as to generic distribution; for the Pelecypoda, especially *Trigonia*, *Cyprina*, *Cucullæa*, and *Natica*, are represented by specimens of great size, while the Gastropoda, *Turritella granulata*, *Murex calcar*, and the beautiful little *Aporrhais calcarata*, are also in great abundance. In the higher beds of the Cretaceous series both the Gastropoda and Dimyaria rapidly diminish in size as well as number, the genus

Pleurotomaria alone persisting and presenting a few isolated examples sparsely scattered throughout the Chalk strata.

The questions as to the distribution of these larger molluscs, and as to the bathymetric range of littoral or shallow-water animals, especially in their relations to oceanic currents, are of great interest; but having confined my remarks in this paper to a comparative analysis of two oceanic periods separated by a wide interval of time, I would now merely summarise the general deductions.

1. In Upper Cretaceous times the principal gastropod genera, which subsequently became so prominent in the early Tertiaries, were fully established on the shores of the South German Continent, and attained gigantic proportions yet further to the south at Gosau in the Tyrol, and in the Hippuritic Limestones. Outside European areas, gigantic *Helcions* have been found by Schmidt in Saghalien, and a rich gastropod fauna occurs in similar deposits in India and Natal, including such types as *Fasciolaria* and *Chemnitzia*. The rarity of Gastropoda and Dimyaria in the Chalk strata of Britain is due to the physical conditions under which they were deposited. The presence in Ireland of a more abundant molluscan fauna is evidenced by some thirty gastropod specimens from Lisburn and elsewhere, now in the Jermyn Street Museum. The principal genera are *Trochus*, *Turritella*, *Rostellaria*, *Turbo*, *Pleurotomaria* and *Scalaria*, which are a further proof that shallower-water conditions prevailed in those localities during Upper Chalk times.

2. The "Challenger" Expedition has revealed to us the general characters of the bathymetric distribution of the Mollusca, and has shown that, instead of these being divided into several classes differing from each other according to the depth, a few genera only, having many shore-line representatives, are capable of extending their range to the greater depths. The reasons for such extension are at present uncertain, but the fact is clear that the trochoid Gastropoda (*Trochus* and *Bacilissa*), *Dentalium*, *Pleurotoma*, and the thin-shelled Pelecypoda, *Neæra*, *Callocardia*, with *Arca*, have special abilities for overcoming these unfavourable conditions, while Monomyaria are most independent of external circumstances.

3. The molluscan fauna from the Upper Cretaceous of Northern Europe has a general distribution markedly similar to that existing in the present oceans. In the Cretaceous strata adjacent to the continental shores, the Gastropoda and Dimyaria have a preponderance over the Monomyaria, similar to that observed at the present day, while in the deeper-water strata these latter assume the lead in a most striking manner. Further, many of the genera extending their range under present conditions, more especially *Dentalium* and *Arca*, are identical in character and habits with those of past ages. The evidence, therefore, tends to establish my thesis, that the distribution of the Mollusca has presented in the main the same features ever since Upper Mesozoic times.

4. Additional evidence is brought forward to show that molluscan life-provinces were marked out even before these remote periods, and that any subsequent changes have arisen mainly through the variations in climatic conditions, and the alteration in the character of the barriers that separate the marine areas into different well-marked basins.

This article, then, has attempted to show that the laws governing the distribution of the Mollusca and Foraminifera, even so far back as Cretaceous times, were similar to those now in force, and that consequently the deductions from a study of present ocean life may be applied in determining the general features of ancient oceans. If this be conceded, a simple comparison of faunas may enable us to determine variation in bathymetric conditions, even where lithological characteristics are of no assistance. Thus, tracing step by step the history of an ancient oceanic area, many inquiries may be suggested which can only be answered by researches pursued in the future on well-marked scientific lines like those of the "Challenger" Expedition

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II.

Murray's Mud-Line.

THE quotations from Professor Herdman, contained in an editorial note in the October number of NATURAL SCIENCE, do not convey a quite correct idea of what Dr. Murray has written with regard to the position of the mud-line off continental shores. As the "Challenger" volumes are not very readily available, the following extracts bearing on the subject will, I feel sure, be interesting to many of your readers:—

"Notwithstanding some exceptions, due to special conditions, as, for instance, on deep ridges between oceanic islands, where gravelly deposits are found, or in bays, fjords, and enclosed seas, where mud is met with in shallow water, it may be said that, along all coasts situated in or fronting the great oceans, 100 fathoms is the average depth at which fine mud or ooze commences to form. At about this depth the deposits on the whole assume a greater uniformity of composition and grain, and the signs of mechanical action tend to diminish or completely disappear. The greater the extent and depth of the ocean, the greater the depth to which wave-movement extends, and consequently the greater is the depth at which the mud-line is formed around the coasts, but the average depth of this mud-line may be taken as approximately about 100 fathoms." . . . . "We have seen that while the depth at which these muds form in enclosed seas or estuaries may be only a few fathoms, yet along all the continental shores facing the great ocean basins the average depth of the mud-line may be taken at 100 fathoms." ("Deep-Sea Deposits," pp. 185, 228, 229.)

"The terrigenous deposits are chiefly made up of materials derived from the disintegration of the land masses. In shallow depths, where the bottom is swept by waves and currents, these deposits consist chiefly of sands, gravels, and boulders; but in all hollow or cup-shaped basins within the 100-fathom line, and in all the greater depths beyond 100 fathoms, the deposit is rarely disturbed by the motion of the water, and generally consists of a fine plastic Blue Mud or Clay. The depth at which a fine mud may form in the sea depends entirely on the depth of water and the extent of the basin; or, in other words, on the height and length of the waves. In harbours it may be deposited not deeper than 1 or 2 fathoms,

while along the western coasts of Scotland and Ireland, which are exposed to the waves of the wide and deep Atlantic, the true mud-line may be situated at a depth of about 150 or 200 fathoms." (*Trans. Roy. Soc. Edin.*, vol. xxxvii., p. 482.)

"In the shallower reaches of the ocean the materials on the bottom are assorted and distributed by currents in a way that produces a great variety of conditions. In some places there are siliceous or calcareous sands, in other places dead shells and pebbles; on submarine banks, rocks and boulders prevail; in depressions, fine muds and clays. On each of these bottoms there is usually a very different assemblage of animals. So that, although the trawl may not in shallow water bring up such a variety of organisms in any single locality as from deeper water, still the total number of genera and species inhabiting the whole area of depths less than 50 fathoms is recognised as much greater than in deeper water. With increasing depth, not only the nature of the deposits, but the other physical conditions, become more and more uniform, till a depth is reached along the continental shores facing the great oceans immediately below which the conditions become nearly uniform in all parts of the world, and where the fauna likewise presents a great uniformity. This depth is usually not far above nor far below the 100-fathom line, and is marked out by what I have elsewhere designated as the *Mud-line*.

"In all modern seas the depth at which minute particles of organic and detrital matters in the form of mud begin to settle on the bottom of the ocean is important both from the physical and biological points of view. This depth is determined by the distribution of land and water. It is dependent on the depth and extent of the ocean or basin, and varies temporarily with seasons of strong winds and calms. In small enclosed arms of the sea, like those of the west of Scotland, the mud-line is situated at depths of from 5 to 20 fathoms; but where currents rush through narrow passages or over submarine barriers, it is much deeper. In the North Sea, the oceanic mud-line to the north occurs at a depth of about 80 fathoms, but on the coasts of Scotland facing the great stormy Atlantic it is often found at a depth of over 100 fathoms. In the Faroe Channel the currents rush over the Wyville-Thomson Ridge with sufficient force to prevent mud forming on the summit, and the mud-line is met with on either side of this ridge at about 300 fathoms. In basin-like depressions within the 100-fathom line—like the Silver Pits of the North Sea—mud is formed, while it cannot rest on the rims of these basins. All the minute organic particles washed down from the land, carried away from the shallow waters by currents, or derived from the decay and death of pelagic organisms, ultimately find a resting place on the bottom in deep water, principally just about and beyond the mud-line." ("Summary of Results," pp. 1433-1434.)

These quotations show that Murray fully recognises the fact that fine mud may be found at a great range of depth, and that he considers

100 fathoms to be about the *average* depth at which it is formed on continental shores facing the great ocean basins. Alexander Agassiz, one of the greatest living authorities on deep-sea dredging and marine zoology, in a review of the *Summary* volumes of the "Challenger" report, says with reference to the position of the mud-line:—

"Undoubtedly the 100-fathom line is an important limit of depth and indicates usually the edge of the oceanic continental slope. Yet it seems to us as if the more limited deep-sea explorations of the *Blake* and the *Albatross* along continental slopes indicated that in many localities there was considerable variety in the nature of the bottom, as, for instance, in volcanic and coral-reef districts and off rocky shores, where faunal conditions of very great variety extend to depths considerably beyond the mud-line and approach very near the 500-fathom line. We should be inclined to extend the limit of uniformity into greater depths than 100 fathoms along the oceanic continental slopes—certainly to 150, and often to more than 300 fathoms.

"While we fully agree with Murray in considering the fauna living near the 100-fathom line as probably that from which the deep-sea faunæ were derived, it seems somewhat hazardous, in our present state of knowledge, to affirm as emphatically as he does that the majority of the animals living within the 100-fathom line have pelagic larvæ, while the majority of those living at the mud-line have a direct development like those found in very deep water."

Thus, while Professor Herdman appears to argue that the mud-line should be placed at some depth less than 100 fathoms, Professor Agassiz thinks that it should be placed at a greater depth. But, making allowance for local conditions and variations, Dr. Murray is probably near the truth in assigning an average depth of about 100 fathoms to the mud-line off continental shores bordering the great oceans. Dr. Murray says that in and on the thin red watery surface-layer of a blue mud there are many living organisms, while in the stiff blue layers beneath organisms are much less abundant.

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III.

On the Darwinian Hypothesis of Sexual Selection.

II.—The Case of the Wall-Lizard.

MESSRS. Hudson and Stolzman have already urged against sexual selection that an argument based on a number of cases selected from all quarters of the globe is obviously unfair. I propose in the following to examine as a test case, and in the briefest possible manner, some of the decorative variations of *Lacerta muralis*, undoubtedly a "higher animal," in order to see what light can thereby be thrown on this problem.

As the vivid green or blue tints that sometimes adorn the body of the male during the breeding-season cannot claim to be more than "general brilliancy" as opposed to a "disposition of colours," I will enumerate only, without admitting the justice of this distinction, some less ephemeral embellishments.

The lower surfaces, generally white, are often marked with a delicate and symmetrical net-work, sometimes with a rich profusion, of pink or yellow or black. The throat also varies. It is often spotted half black and half red, and its colours occasionally contrast with those of its under parts. The outer ventral scales generally have a blue or black centrepiece, now and then a green one, and not rarely the plates are alternately coloured blue and black, or green and orange, etc. Or, again, the outer row of ventrals may be blue and the next green. To show how complicated these patterns may become, I will describe one male captured on the Filfla rock, near Malta. The first row of ventrals on both sides of the body was blue on the outer half and black on the other, the demarcation being sharply defined, the next row was precisely similar, while the inner two rows were of a rich ochre yellow. Thus there were five parallel lines of regular and most attractive coloration. The throat and collar of this specimen were symmetrically spotted with sky blue. The large *scutum anale* was jet black, and the soles of the feet spotted black, with the single joints of the toes marked green.[1] Another

[1] This is something like the *var. Rasquinati*, described by Bedriaga: "Beiträge zur Kenntniss der Lacertiden Familie," p. 177.

ornament is made by the ocelli at the root of the front legs. They display no less eccentricity. As a rule, we find only one eye-spot, sometimes two, or even indications of a third. Or there may be two on one side and only one on the other. Like the other decorative colours, these ocelli are most pronounced in the male sex, and they are, as anyone acquainted with this species will admit, distinct from the ground-colour, ranging through every shade of cobalt, sea-green, and bronze, and generally framed in a ring of black.

These examples will suffice to show that the matter is not one of "heightened coloration," but essentially of ornamental design. To anyone who has observed the animal in its native haunts another fact will have become equally clear: that the surprising variability among adult individuals, even from one locality, demonstrates that these designs cannot be adaptive in any sense of the word.

If, therefore, this manifold ornamentation of *L. muralis* be due to preferential mating, we can only conclude that the females vary much in their tastes, and that these tastes must be of an order high enough to appreciate the minutest differences. To take an instance. Supposing two varieties of birds or of butterflies were distinguished by blue and green ocelli respectively, sexual selection would be called in to account for their differentiation. On applying the same hypothesis to *L. muralis*, the formation of *var. viridi-ocellata* out of *cæruleo-ocellata* (or *vice versâ*: it is immaterial which of the two has the priority) must be explained by assuming divergent tastes, and an ability to humour them, on the part of the females. Or, again, the non-adaptive *var. rubriventris* that occurs often singly among the (older) white-bellied form, but has elsewhere established itself to the exclusion of all others (a "local fashion")—this variety can only have arisen through long-continued "selection" of the red under-surfaces.

If so, we might expect to see something in the shape of display on the part of the male, or of choice exercised by the female. I have detected nothing of the kind, and am aware of no recorded observations to this effect. On the contrary, my experience goes to show that the individuals interbreed freely, without consideration for colour, and this agrees with other accounts.[1] It is true that Professor Eimer has explained facts like that adduced by Giglioli,[2] of two distinct varieties occurring together on a small islet by the suggestion that a "profound antipathy" exists between them which prevents their interbreeding and to which the frequent battles bear testimony,

[1] "The so-called races commingle freely" (Bedriaga, "Die Faraglione-Eidechse," 1876, p. 12). "Il y a peu de fidélité dans la gent Lézard, et les deux sexes aiment également le changement" (Fatio, "Vertèbres de la Suisse," vol. iii., p. 65). Professor Leydig informs me that he has never observed anything in support of the sexual selection theory with lizards. Mr. Boulenger writes in the same sense.

[2] In *Nature*, no. 475, vol. xix., p. 97.

"while the similar individuals breed together."[1] But I venture to think an easier explanation lies at hand. The "distinctness" of the adults may be referred to what is a common enough phenomenon among animals and plants, namely, that the offspring of two varieties is not intermediate between them (or only so while young), but assumes the character of one or the other parent form. As to the contests, they take place indiscriminately between the individuals of either variety and are generally provoked, no doubt, by disputes over food. This is a *vera causa* for enmity between individuals as between races, when brought into contact by identity of requirement; but there is no reason whatever why, in the case like the present one, the individuals of var. *a* should be more hostile to those of var. *b* than towards each other. As a rule, pugnacity in lizards is an individual matter, but *L. muralis*, as a species, is certainly more pugnacious than many. Two males may often be seen rushing at each other without the slightest apparent reason. Perhaps the feeling of rivalry is also strong; but I should like to say, in order to avoid misunderstandings, that the female takes no art or part in the contests of the males—it is quite by accident if there happens to be a female spectator—and even supposing some form of courtship to be decided by wager of battle, she would be compelled to accept the victor, however distasteful his style of ornamentation might be to her preconceived notions of beauty.

The whole question of sexual selection, therefore, with this species, and innumerable others, turns on this simple matter of observation. I submit that wherever such promiscuity among the individuals exists as with *L. muralis*, it is a contradiction in terms to state that decorative colours have been evolved through the choice of particular males by the other sex.

I might add that the same difficulty of analogous variability, previously mentioned, presents itself in another shape. The wall-lizard of the islands of Malta and Seriphos is apt to assume a brilliant yellow patch on the throat. Unless this is adaptive in some way it would imply a curious coincidence in taste on the part of the females of these widely-separated races. The *var. nigriventris*, a recent form, whose colour cannot be adaptive in any sense of the word, occurs at Genoa and at Algiers: can it be presumed that an identical change of female æsthetic conceptions has taken place in these different localities? The same applies to the *var. flaviventris*.

There is, lastly, a difficulty on what may be termed mechanical grounds. I have purposely described the detailed colour-pattern on the lower surfaces of a specimen from Malta. How is the female to see it?

[1] Eimer, "Organic Evolution," translated by J. T. Cunningham, p. 42; "Variiren der Mauereidechse," 1881, p. 79. The author attributes a certain influence in the colour development of this species to sexual selection. "Zool. Studien auf Capri," ii., *passim*. "Variiren etc.," pp. 22, 27, 158.

Thus one species of "higher animal," at all events, must content itself with any physiological makeshift it can find to explain the production of its ornamental colours. Perhaps others of its order fare no better. And whoever is inclined to generalise from this conclusion will feel how difficult it is to assume, on the Darwinian hypothesis of preferential mating, that the æsthetic faculties attributed to female birds, and employed by them in the improvement of male fashions, should lie dormant throughout the next Order, Reptilia, and afterwards suddenly reappear, in their full complexity, among the Lepidoptera and Arachnida. Such an assumption must, indeed, be rejected, if only on the ground of the close analogy between the secondary sexual characters of birds and those of reptiles.

I should like to append one or two remarks on the melanic insular races of *L. muralis*, whose genetic development has some bearing on the question of sexual selection. In speculating on the origin of their strange coloration, it would be satisfactory if we could dispense with the all-explaining "external influences"; for their—biologically—isolated position becomes more apparent if neither physical nor economic conditions have contributed to this result.

Now, as to the first of these, although dark coloration in this class of animals has been ascribed in some instances to moist surroundings, in others to the action of light-rays (whose irritating influence on the smaller vessels may induce a deposit of pigment under the epithelial layers), yet, in the case of island varieties, exterior agents such as these must affect either all of them or none. Nor have economic or social causes, arising out of the relation of these races to other organisms, played a part; the "protective coloration" hypothesis which has been advanced does not seem tenable, for the following reasons:—(1) If the dark upper surfaces of the Faraglione-lizard are adaptively-imitative of the fissures, etc., in the rock,[1] it is surprising that the lizards on the neighbouring and similarly coloured islet should be, not black, but sky-blue[2] on that portion of the body. (2) The summit of the outer rock is covered with vegetation, and has a certain depth of soil (the elder Spadaro, who used to ascend it, planted a crop of potatoes there). Thus the adaptation could refer only to the sides. (3) On other Mediterranean islets of the same colour and geological structure as the Faraglione the lizards are differently coloured. (4) The fact that the Faraglione race is exceptionally tame (more so than any other insular or continental race with which I am acquainted), and that (5) the females are almost as brightly tinted as the males, indicate they have few, or no, enemies, and therefore stand in no need of protective coloration.

I must apologise for this digression. It would be interesting if races like *L. lilfordi*, *L. cærulea*, etc., could be shown to have been

[1] Eimer, "Studien auf Capri," ii., pp. 36 *et sqq.*

[2] Eimer, "Varitäten, etc.," p. 154.

formed, so to speak, of their own sweet will, and free from the restraint of Natural Selection. This seems to allow wider scope to sexual preferences. But I can find no particle of evidence that the curious tints of these varieties or certain structural peculiarities have been thus acquired. The males are exceptionally pugnacious,[1] of large size (due to a succession of combative ancestors), and in unusual preponderance over the females[2]; but this is negative evidence.

To obtain some idea how these insular races have gradually deviated from the parent stock, one may compare the lizards on the town-walls of ancient Paestum, a comparatively isolated area, with the common Neapolitan form. Both the *var. maculata* and *elegans* are here represented, but they are larger in size, and the throat and lower surfaces are suffused in early spring with a decided blue tinge. Perhaps they would become a biological species analogous to the Faraglione race, if the innate tendency to increase the supply of normal pigmentation were uncontrolled; as it would be, if greater isolation destroyed the equilibrium between competing species and rendered superfluous all protective coloration. This, I think, is what has taken place with the Faraglione lizard and others; but such changes are not effected even on small islands of the size of Capri or Malta, for here the struggle for existence, so far as *L. muralis* is concerned, is as severe as on the mainland.

Whoever turns to these melanic races to elucidate the problem of sexual selection will find them instructive from at least two points of view. They illustrate, in the first place, a change in the direction of variation. I do not propose to criticise Professor Eimer's suggestive "Law of Undulation," beyond saying that even if the archetype of this species was longitudinally barred, and if these bars show a tendency to break up into vertical markings, it does not necessarily follow that all other forms are intermediate in the sense of "less advanced," and represent so many stages of standing still (*Genepistasis*) in the course of phyletic development. The principle of evolution seems to be broader. The *var. elegans*, for instance, or the Faraglione lizard, whose primordial [?] stripes can be plainly detected on speci-

[1] Five out of ten males from the Filfla rock had their tails broken off short, presumably during occasional encounters. This is far above the average of such mutilations. Bedriaga and Eimer testify to the combativeness of the Faraglione lizard. The females are said to be almost as bellicose as the males.

[2] This is as yet only a supposition, and remains for future observers to determine. The numerical proportion of the sexes in many animals depends, to some extent, on climate, nutrition, etc. On the Filfla rock the proportion obtained was ten males to four females, and from the Faraglione four males to two females, although the females are everywhere more easily caught. This disproportion is not borne out by the small material in the British Museum, but Professor Eimer notes that "much fewer" female Faraglione lizards came into his hands than males, a fact which he attributes to their greater shyness. I have found, on the contrary, that the male wall-lizards are always more shy and active than the other sex, and this accords with the experience of Professor Leydig ("Die in Deutschland lebenden Arten der Saurier," p. 157).

mens that have lain some time in spirits of wine, have suspended the further development of all markings. They have abandoned the "predestined" line of modification and are tending each to accentuate its own (uniform non-striped) varietal type. Another case. The males of *L. agilis* generally obliterate in spring all traces of their usual darker markings in a glow of vivid green, yet some of them embellish, particularly at their season, their longitudinal dorsal stripe. This would signify retrogression and more than arrested development. The same with batrachians. The spots of *Salamandra maculosa* are apt to coalesce, with approaching maturity, either into vertical or horizontal lines. The one type is commoner in the North, the other in the South of Europe, perhaps for a similar reason to that why the varieties of other reptiles and batrachians are striped in the East and become ocellated towards the West. Whatever this reason may be, the second of these processes is directly opposed to the theory of the undulatory progression of markings.

In objecting, therefore, to its wide applicability,[1] I take my stand on cases like the *var. elegans* or *bi-fasciata* of the wall-lizard. The nisus of the variety, quâ *elegans*, etc., is more conspicuous in the male than in the female or young. If the latter portray more faithfully than the males the ancestral coloration, the present race must be assumed to advance along new (male) lines of variation, a process which involves a discontinuance, partial or complete, of whatever may have been *the* one original direction followed by the parent stock. Such considerations point rather to a progressive divergent development, though, of course, some species are more conservative than others in the matter of variation, both as to its degree and its direction.

The bearing of the class of facts briefly hinted at upon the theory of sexual selection is obvious. If the decorative stripes of antelopes and tigers,[2] the delicately pencilled markings of many birds, the eye-spot of the peacock-butterfly, or the dark streaks of the swallowtail have been formed according to sets of rules similar to those that have regulated the differentiation of the innumerable striated, speckled, ocellated varieties of the wall-lizard, where sexual selection is shown to be out of the question, what is their value as proof of such selection?

This relates only to the modification or suppression of markings. The insular races of *L. muralis* are noteworthy also as exemplifying the process whereby mere heightened coloration can become permanent. The late G. J. Romanes joined issue with Mr. Russel

[1] Eimer's conclusions as to the origin of vertebrate markings have not remained uncontested (v. *Zool. Jahrbücher*, 1893, p. 382). The new edition of Brehm's "Thierleben" classifies the Felidæ according to the method suggested, and it seems to be a useful one for this purpose. I am not aware whether Professor Eimer has adduced, in favour of his theory, the very interesting changes which the five lines on the heads of certain newts undergo so as to form, finally, an almost vertical pattern.

[2] "Descent of Man," p. 544.

Wallace on what he considered a most important point, namely, the distinction between "general brilliancy" and a "particular disposition of colour."[1] The former, he admitted, might readily enough accompany an increase of vigour; but the latter "exists for the sake of ornament." This difference, I venture to think, is more apparent than real. Speaking of animal tints in general, every gradation can be traced between the most volatile hues produced under the influence of love, jealousy, etc., in one sex, and the intensified coloration peculiar to the whole breeding season. The latter, in its turn, may not rarely be retained and become a fixed character in both sexes all the year round. Further, if there is any truth in the biogenetic law, it is probable that what is a "design of colours" nowadays was, at one time, only "heightened coloration," and that a complete transition has existed between the one and the other. This is, naturally, not easy to demonstrate, as we have no written record of the ancestral coloration of any animal; but a clue can be obtained from what is going on at the present day. I have elsewhere drawn attention to the fact that the emerald lizard in certain localities displays an evanescent bluish tinge about the head and shoulders which may be regarded as an intermediate stage leading to the true *mento-cærulea* form, adding that "the distinguishing blue patch on the throat of the latter is, in many localities, of the most ephemeral nature; in others, it is retained long after the honeymoon, and in some, again, the lizards are perpetually thus coloured. Finally, this same feature is not rarely peculiar to the male sex, but elsewhere equally conspicuous in both."[2] Now, the bluish tinge first noticed is clearly nothing more than heightened coloration; but whoever has examined typical specimens of the *mento-cærulea* variety will admit that it exhibits a particular disposition of colour, and a very pretty one, and one that has evidently crystallised, in the course of time, out of ill-defined brilliancy. Unless this is a unique case, unsupported by anything in the natural history of birds and mammals, I do not see the force of the objection raised by Romanes.

The bearing of facts such as these upon the question of sexual selection is simply this: If the delicate green ocellus at the root of the *hinder* leg of the Faraglione lizard or the complicated design on the lower surfaces of the Filfla lizard, has developed without the assistance of female preferences, why invoke their agency to account for the patch of colour on the bluethroat's breast or on the head of the woodpecker?

If the tendency of biology is to become a more exact science every day, the processes involved in the formation of animal pigments will soon be, if not reducible to a scale, at all events familiar enough to show whether order cannot be brought into the "fortuitous

[1] "Darwin and after Darwin," i., p. 394.

[2] "Herpetology of the Grand Duchy of Baden," p. 9.

concourse of atoms of colouring matter" without external (female) sanction. I think it will be found that the harmonious distribution of tints on the feather of the argus pheasant merely continues a principle which the bilateral and radiate forms of all living organisms illustrate—the coincidence of symmetry with economy; and that, although "likes and dislikes" will always exist, sexual selection, from being an efficient cause, becomes an untimely *deus ex machina* like so many others.

So far the remarks have not been constructive, but one suggestion, at least, of a positive nature may be gleaned from two facts in the life-history of *Lacerta muralis*.

The first of these is that, considering the number of enemies, four-footed, winged, and creeping, that persecute this species, the struggle for existence must obtain as severely here as with any other animal. The second fact relates to the predominance of some varieties over others, and becomes apparent if we trace their manner of colour development. In the *nigriventris* form, for instance, we see that the black is first visible in the shape of minute spots on the throat, each scale being often prettily marked with a black centre. The next stage consists in the entire under-surfaces being thus covered with minute spots that afterwards, in the true *var. nigriventris*, Bonap., expand to the exclusion of all other colouring. In localities where this variety has become dominant, the first gradation of colour-development has been abbreviated, and the young already display the intermediate stage. The young and females are not so darkly tinted as the males.

From these circumstances we conclude that the parental stock was less strongly pigmented, and also that the present scattered *nigriventris* forms are not the discontinuous residue of a once all-prevalent race, for, in that case, the young would have this feature most pronounced. They must, therefore, have arisen spontaneously, so to speak: independently of each other. Nor can their mutual resemblance be explained by identity of external conditions, for this form occurs sporadically on a variety of soils on different shores of the Mediterranean and on some of its islets, as well as further north.

By what obscure selective process has this preëminently *indifferent* character of black colouring on the lower surfaces been perpetuated and intensified? Considering our ignorance of the causes of variation it would be rash to state that the whole polymorphic cycle of varieties of this species are distinguished by equally non-adaptive characters, but this certainly applies to some other recent forms like the *rubriventris*, *flaviventris*, etc.,[1] whose characteristic tints are of the "useless" class.

[1] The phylogeny of these races is corroborative of the general rule that animal beauty tends to increase, a fact that is sometimes attributed to "growing taste" on the part of the female sex. The effects of sunlight (Eimer, "Organic Evolution," p. 91) cannot explain brighter colouring on the lower surfaces of *L. muralis*.

Viewing together the three varieties mentioned, it looks as if they had diverged from, and multiplied at the expense of, an older stock, by virtue of something inherent in the additional outlay of colouring matter, the precise shade of which seems to be immaterial.

I think that the two facts of the severe struggle for existence and of the predominance which races like *nigriventris* have been able to assert over less pigmented forms afford demonstrative evidence that abundant pigmentation, the expression of intense metabolism,[1] *must* be associated with superior physical vigour. That is, that the most ornamental varieties (*ceteris paribus*) necessarily must—not generally do—increase. If the survival of the physically fittest has coincided, as is here the case, with that of the most intensely coloured, the indifferent characters of this species cannot be regarded as mere awkward bye-products of growth: their formation seems to have been conditional, rather than incidental, to continued existence.

It appears from this that "useless characters" and "characters of no active utilitarian significance" are not interconvertible terms. And unless this conclusion is applicable only in the matter of the production of superabundant colour, and only to the case of *L. muralis*, I think its bearings are not easily appreciated.

Speaking apart from structures and anything else that may possess a life-preserving value, it may be said that an unbroken gradation exists from the most decorative ornaments of higher animals, peculiar to one sex, to the wider class that contains the ordinary non-ornamental useless characters of higher and lower animals of both sexes. And it has been remarked with surprise that representative or allied species of animals and plants often differ from each other in respect of such non-utilitarian (morphological) characters, whence the awkward question has arisen how they ever came to be differentiated, seeing that it mattered nothing to their ancestors, as varieties deviating from another type, whether they possessed this or that non-adaptive feature. Why should they have survived while others perished?

The sphere of utility would be extended if, reviewing them as we now do the dominant sub-species of *L. muralis*, we could demonstrate that their ascendency over innumerable, afterwards extinct, connecting forms had been determined by a physical superiority, to which the "useless" character, whatever it be, still bears testimony.

G. Norman Douglass.

[1] Geddes and Thomson, "The Evolution of Sex," p. 23.

Ljustr. Gen. Stab. Lit. Anst. Stockh.

The Swedish Marine Biological Station

from the land.

IV.

The Swedish Marine Zoological Station.

A MISTY day last summer found me steaming up the west coast of Sweden to the little village of Fiskebäckskil, on a wild-goose-chase after some friends who had left before I arrived. Landed here, in a place without an inn, and without another steamer to take me away that day, I cast about for somewhere to spend the night. Then on the other side of a little bay I saw some white buildings and a vane-capped tower which they told me belonged to the zoological station of Kristineberg. Relying on the freemasonry of science, I at once sought the good offices of the director, Professor Hjalmar Théel. Nor was I disappointed. Fortunate circumstances rendered it possible for me to find a bed there for a couple of nights, and to make the acquaintance of the laboratories and those working therein. The somewhat remote position of this station and the rule that forbids other than Swedes to work there, render it less known to Englishmen than its scientific importance demands; and it occurred to me that a short account thereof might interest the readers of NATURAL SCIENCE. It so happened that Professor Théel had just brought out a little 48-page pamphlet "Om Sveriges Zoologiska Hafsstation Kristineberg" (Stockholm: Norstedt & Söner), with a map and four plates; and with his kind permission the present article draws largely on both his text and his illustrations.[1] For his hospitality and his help he has my warmest thanks.

The island of Skaftö, on which Kristineberg is, lies on the south side of the Gullmar-fjord, near its mouth, and is about half-way between Gothenburg and Uddevalla, with which places the neighbouring village of Fiskebäckskil is in daily communication by steamer. This situation offers many advantages: the fjord cuts deep into the land, and has a varying bottom of clay, gravel, rock, *Zostera*, algæ, shells, and mud; immediately outside Kristineberg it reaches a depth of thirty fathoms, and six miles further up a little over eighty fathoms. A number of rocky islands shelter the mouth of the fjord against the sea (Fig. 1). Animal and vegetable life is richly represented and provides a boundless field for research. Hence Kristineberg early was a

[1] This pamphlet also contains a list of the marine biological stations of the world and a bibliography.

FIG. 1.—Sketch-map of the Coast near Kristineberg.

favourite resort of Swedish naturalists, and became a recognised zoological station by a process of natural evolution.

It was Bengt Fries who in 1835 first visited Kristineberg, and was so pleased with the place that he returned there in 1837 and 1838 with W. v. Wright to study and to collect specimens for the State Museum. In 1839 Sven Lovén paid his first visit to Kristineberg, and it subsequently became the place where he carried out many of the beautiful researches of which some account was given in the October number of NATURAL SCIENCE. Dredges and other apparatus necessary for investigating the life of deep-sea animals gradually accumulated; moreover, Lovén trained two of the local fishermen, Bengtsson and Jacobsson by name, not only to manage the dredge and collect specimens, but also to know the names of the commoner forms. These advantages induced many other naturalists to spend their summer holidays at Kristineberg, and among them may be mentioned Anders Retzius, C. J. Sundevall, J. E. Areschough, Johannes Müller, W. Lilljeborg, G. Lindström, T. Thorell, O. Torell, F. A. Smitt, Chr. Lovén, R. M. Bruzelius, A. J. Malmgren, and O. T. Sandahl. In a word, Sweden had a sort of zoological station earlier than any other country.

But a real Zoological Station, with authority and endowment, was required. This was recognised by Lovén, and it was owing to his exertions that the station of Kristineberg was founded. The capital was obtained from Anders Fredrik Regnell, who, while making his fortune as a physician in Brazil, often remitted large sums of money to the scientific institutions of Sweden, and, on his death, bequeathed to them the remainder of his wealth. From him the Royal Academy of Science received in all rather more than £3,000, in order to found a zoological station that should belong to the Academy; and Lovén was requested to put this into effect. Naturally, the Kristineberg locality was selected; the land was supplied by the trustees of the Royal and Hvitfeld Scholarship at Gothenburg, and in July, 1877, a bargain was concluded with Captain E. Bengtsson for his house, with boathouses, store-sheds, quays, and half of a brewhouse. Nothing more was needed than to take over the arrangements already made; the station was at once thrown open to researchers, and in August of the same year we find five young students installed there, namely, T. Tullberg, F. R. Kjellman, Hj. Théel, Chr. Aurivillius, and J. Brattström.

Another factor aided in no small degree the first development of the station. Sven Lovén for many years had sought to get up expeditions to study the animal life of the Swedish seas, and specially to investigate the comparatively great depths, up to 400 fathoms, that are to be found in the Skagerack. At the request of the Academy, Parliament appropriated £555 to this purpose, and during the summers from 1877 to 1879 placed at its service the gunboat "Gunhild," completely equipped and commissioned. The scientific

men that took part in these expeditions were Hj. Théel, who was on all three, C. Bovallius, F. Trybom, C. Forsstrand and J. Brattström. The expeditions, which started from the station of Kristineberg, were richly supplied with apparatus from the naval station of Karlskrona, and at their close all this was handed over to the zoological station.

The buildings belonging to the station are the following. On the right-hand side of Plate XX. one sees the dwelling-house, a long building of rough-hewn timber and boards, facing north-east. On the ground-floor are the large sitting-room, smaller dining-room, one small and two large bed-rooms, kitchen, and servants' bed-room. The upper storey consists of five bedrooms opening upon the large top-landing that is characteristic of Swedish houses. An uncovered verandah stretches along the front of the house, and on it one drinks one's coffee after dinner and admires the extensive view over the Gullmar-fjord. Board and lodging can here be offered to nine or ten people at once, and for it one pays two kronor (2s. 3d.) a day. The house on the left-hand side of Plate XX. is the so-called Villa, the residence of the director, with three rooms, a kitchen, and a glass-covered verandah on the ground-floor, and two attic rooms above. Behind it are seen the necessary outhouses. To the right of it is seen a cottage, containing a workshop and a mangle-room. The wooden boathouse, not shown in the Plate, is down by the water's edge on the right; in it the dredges are stored, and rough work carried on.

The laboratory building and its adjoining water-tower were not completed till 1884. The main building, which is seen in the middle of Plate XX., of two storeys and built of wood, is 18 metres long and 10 wide. It has one entrance at the east end and one in the middle of the south or landward side. All the inner walls are panelled and varnished. The floors of the lower storey are soaked with tar and linseed oil, while those of the upper are varnished and somewhat noisy to walk on. A notice on the south entrance informs the would-be intruder that this door is only for workers. The east entrance, however, is at certain times open to the public. We enter through a lobby (*Ö F* in Fig. 2) up a short staircase directly into the large so-called "washing-room, *sköljrummet*," 10.5m. by 6.3m. (*S* in Fig. 2). On its north side are three windows, in front of which runs a broad platform, on which are placed five aquaria (*a*, *a*, *a*), each containing 175 litres. This platform is made of strips of planking, between which rubbish can fall down onto the underlying rock and be washed into the sea. Immediately under the windows a long table (*vb*), fastened to the wall, runs the whole length of the room. It is used for the coarser dissections, for picking out animals from the seaweed and so forth brought in by the dredgers, and for spreading out masses of clay, which are left untouched during the night so that the animals living therein may crawl to the surface. Between two of the windows is fitted a washing apparatus for sifting the clay and discovering the small and often microscopic animals that inhabit it.

In the table is also a sink (*s*), while from it small lifts (*h*) ascend to the work-rooms above. Along the room is a row of pillars supporting the ceiling.

From the small eastern lobby, two other doors on the right hand lead to the large cement aquaria (A_1 and A_2), containing 3,000 and 1,000 litres respectively. By a third door on the left one enters a fair-

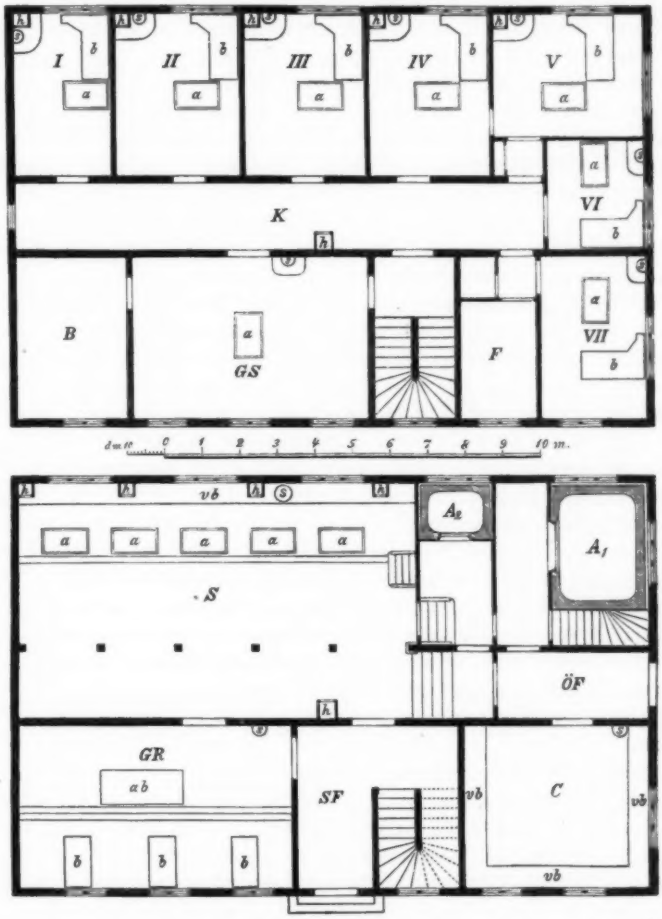

FIG. 2.—Plan of the two storeys of the Laboratory at Kristineberg. For explanation of letters, see the text.

sized sorting- and store-room (*C*), with three windows, and with tables fastened to the walls round three sides (*vb*). In this room is kept the stock of reagents and alcohol, and here the catch brought by the dredgers is daily delivered and is sorted for division among the different workers or for preservation at the Natural History Museum.

In the south-west part of the lower storey is a general working room (*GR*), 7·34m. by 4·4m. with three windows and with exits to the washing-room and the south entrance-hall (*S F*). It has three work-tables (*bb*), and in the middle a large aquarium-table (*ab*). This room is set apart for younger students, who stay at the place in order to get a general idea of the flora and fauna of the sea.

From the south entrance-hall, which is more spacious than the other, and which has doors into the general room and the washing-room, a stair leads to the upper storey, which contains the laboratories proper. A long corridor (*K*) divides this storey into two halves, and from it doors open into the seven studies (*I.–VII.*), which face north and east, into a smaller store-room (*F*) for glass and reagents, and into a large common room (*G S*), lit by three windows facing south, and opening into a small corner room (*B*), also facing south, which is intended to contain the library of the station at some future day. In the common room is a work-table, reserved for emergencies, a warming oven, microtomes, a named collection of animals from the neighbouring sea, and so on. This room is principally to be regarded as a common study for those who wish to use the collection for comparison, to use the warming oven for imbedding in paraffin and such like work, and to use the microtomes. Each private study has on an average an area of twelve square metres and a height of a little over three metres. Each contains a large, excellent work-table (*b*) with solid oak top, a treadle arrangement for the lens-stand after Sven Lovén's model, and a set of drawers. Each is provided with a dissecting microscope, a bookshelf, a copper-covered aquarium-table (*a*) with waste pipe, a sink (*s*), water supply to the aquarium-table and sink, a set of glass vessels and aquaria of different sizes, a lift (*h*) from the washing-room, and all necessary reagents, which are supplied on demand. Microtomes, balances, warming ovens, a Hartnack microscope of high magnifying power, and similar apparatus, are kept for the common use and are lent out as required.

From the upper storey a staircase ascends to a light and spacious attic.

Altogether the laboratory furnishes working room for ten persons at once, the common room not being included, since it ought to be accessible to all, and its only work-table is kept in reserve in case some eminent naturalist should turn up unexpectedly.

The whole building is traversed by pipes, which supply the aquaria and the studies with fresh sea-water; the supply to the upper storey and to the large cement aquaria consists of iron pipes enamelled on the inside. The supply of the lower storey, which was installed in 1894, consists of very wide, thick-walled glass tubes surrounded by a somewhat larger cover of brass, while the space between the two is filled with a mixture of wax and Venetian turpentine. All the T-pipes and angle-pipes of this new supply are constructed of well-tinned brass, and the cocks are of ebonite.

The water-tower is hexagonal, about 30 feet high, and has at the top an enormous wooden tub with a capacity of 35,000 litres (7,700 gallons). There are two pumps worked by wind-motors, which, in order to catch the wind more easily, are placed about 10 feet above the roof, that is to say, 40 feet from the rock on which the tower stands. The sea-water is pumped up into the cistern and thence distributed all over the laboratory. It happened that while I was at the station there was a day or two of calm, so that the motors did not work, and, to prevent harm to the animals in the aquaria, the pumping had to be kept up by human labour. Such an occurrence is not uncommon in the summer, and it is probable that some safer motor, such as a petroleum engine of two-horse power, will be substituted at an early date.

The station has within its grounds two landing stages, one of which projects far into the water, as well as a stone quay where a steamer can lie.

As already mentioned, the station possesses a rich supply of dredging apparatus, among which may be mentioned nets that can be opened and closed in deep water, and a vertical net after the Kiel model. The fleet of the station consists of two trawlers, to which a new larger one will be added next summer, a smaller sailing boat, and a little rowing boat. It often happens that material for research is not to be obtained in the neighbourhood of the station, but has to be brought from such distant places as the Väder Islands or Koster. For this purpose the boats of the station are too small, and a strong, full-decked yacht has to be hired. But the limited means of the station often make these expeditions impossible, however desirable they may be. A steam yacht is also greatly needed, especially for studying the movements of the plankton, but this also is prevented by want of means.

The staff of the station is composed as follows: The Keeper of the Lower Invertebrata at the State Museum is *ex officio* the Director. In this post Sven Lovén was worthily succeeded three years ago by Hjalmar Théel.

The Overseer takes general charge of the station and its property during the whole year, and, while the station is open, has to see to the boats, pumps, etc., and make himself generally useful.

The Housekeeper lives all the year round at the dwelling-house, taking care of the furniture and properties of both houses; and, while the station is in work, she looks after the living-rooms, cooking, and household duties.

The Dredgers, originally two in number, have now been raised to four. It is their duty to go every day to different parts of the coast to procure the necessary material. Their long training has given them a considerable knowledge of the mode of life, occurrence, and appearance of marine animals.

The station is, as a rule, only open during the three summer

months, since want of funds does not permit it to be open at other times. But during that period it offers considerable advantages to the investigator that is a Swede. With no other expenses than those for his board and lodging, he receives a work-table, all necessary materials and reagents, and the use of all the apparatus and appurtenances that have just been described. That is to say, his total expenses for a month's stay would amount to £3 10s.

NATURAL SCIENCE has occasionally suggested that if a similar generosity were extended to the student by our own Marine Biological Association, no great harm would be done. It is interesting to learn the results of Sweden's experience. Some have, indeed, thought that a fee should be charged in return for these great advantages. But the Swedish student, like many others, is, as a rule, poor. The mere journey to and from the station and the cost of living there are a considerable expense to him. And, as Professor Théel very justly points out, if a fee large enough to benefit the station even to a small extent were charged, that would necessarily react as a hindrance to the pursuit of science. What science gained with one hand she would lose with the other. The learned Director, than whom no one has had a longer experience, therefore thinks that the Academy will best perform its duty of encouraging the development of science in general, and especially of Swedish science, by according to the investigator facilities no less than those he can obtain at Bergen or at Dröbak in the sister-kingdom of Norway, or at the laboratories of Arago and Roscoff in France.

Its generosity might lead one to suppose that the finances of the station were in a flourishing condition. This is by no means the case. The original donation of Regnell, and later donations made by Baron Oskar Dickson with his wonted liberality, have been spent in fitting up the station. The yearly income which the Government grants to the Academy for carrying on the work is not great. In 1878, £55 was allowed; and since 1879 this sum has been doubled. In comparison with the sums spent on similar institutions in our own country, this seems quite ridiculous. Sweden is not a rich land; but it is richer than Norway, which spends just twice that amount on its marine laboratories. When one considers the valuable and beautiful work that has been produced at this station and printed in the memoirs of the Royal Academy of Science and in other Swedish publications, by such men as Lovén, Théel, Tullberg, Kjellman, G. Retzius, the two Aurivillius, Appellöf, Wirén, Nathorst, and many others, one can but express the fervent hope that no shortsighted parsimony may check a stream of so much value to Sweden and to the world.

Among the advantages of this station—its scientific work, its increase of a practical knowledge of marine life, its furnishing of material and museum-specimens to the schools and universities of the country, its enlightening and vivifying of scientific teaching and

teachers, and its promotion of intercourse between workers scattered for the rest of the year—there is one not alluded to by Professor Théel in his pamphlet, for the simple reason that it does not exist. One of the great advantages of such institutions elsewhere is that the worker at them meets with his colleagues from other countries, that the misunderstandings caused by distance are cleared away, and that one is brought out of one's parochial groove on to the broad highway of the world's science. There are, no doubt, excellent reasons why the advantages of Kristineberg should have been reserved for students of Swedish nationality, and chief among these one must reckon want of space and want of funds. Possibly the tax that the Academy wisely refuses to impose on the poor Swedish student might be laid on the foreigner; for I am sure that there must be many who, like myself, would be glad to have a closer acquaintance with the renowned and genial school of Swedish naturalists.

F. A. Bather.

V.

The Use of Formalin as a Preservative Medium for Marine Animals.

EARLY in the present year, my attention was drawn to the use of Formalin as a preservative fluid, by a short account of some experiments carried on by Professor Paulino de Oliveira[1] at the University of Coimbra. Since then, I have conducted in the laboratory of the Jersey Biological Station a series of very extensive tests, having the action of the fluid in question under daily observation. As the original investigation was conducted by Professor de Oliveira on rather restricted lines, and further, as my results differ considerably from his, it may be useful to workers at other stations and elsewhere if I bring together the chief of my methods and state the principal results obtained.

As to the nature of the fluid, it is sufficient to mention that formalin is the name given to an aqueous solution containing 40 per cent. of formic aldehyde. Its chief commercial use at present is as an antiseptic, and from its great bactericidal powers it takes high rank as such.

As a fluid designed to preserve marine organisms permanently, formalin is best used in an aqueous solution of strength ranging from two to eight per cent., and while a two per cent. solution will in many cases give satisfactory results, in practice I find it advantageous, in order to avoid any risk, to employ no solution of less strength than three per cent. Where the animal is bulky, or contains much water, I prefer to use a five per cent. solution. Hence in the following notes, unless otherwise stated, the strength employed must be understood to be that last named. It is to be noted that these percentages are calculated by considering the commercial fluid, formalin, as being of full strength (100 per cent.), although really it is but a 40 per cent. solution of the active principle.

For convenience in referring to these methods, I will treat of the various phyla and classes separately—I will also premise that the use of formalin does *not* do away with the employment of the ordinary fixing agents if the object is wanted for histological purposes. For dissection and museum purposes, there is, however, no need of other fixation than the action exercised by the formalin itself.

[1] *Annaes de Sciencias Naturaes*, vol. 2, no. ii., p. 69. (Porto; 1895.) (*See* also NATURAL SCIENCE, vol. vi., p. 229, April; 1895.)

PROTOZOA.—Perfect preservation, with cilia distinctly shown, is attained in a six per cent. solution. For microscopical fluid-mounts of these organisms, carbolised water and allied fluids may be advantageously discarded for this new medium, and by the use of aqueous staining fluids containing a percentage of formalin, good differentiation can be obtained; weak bismarck brown is one of the best stains to employ.

PORIFERA.—For histological details, formalin preparations are inferior to such as have been thoroughly well fixed and passed carefully into spirit, but the former are infinitely superior to such spirit specimens as have not had the *utmost* care bestowed upon them. The same observation applies fairly universally to other groups.

For ordinary dissection, formalin preparations are equal to the most carefully prepared spirit ones; while for museum preparations, those in formalin are greatly superior, showing absolutely no contraction, and in those where delicate filmy tissue is present the lovely transparency of life is retained almost unimpaired.

HYDROIDEA.—For microscopical manipulation, spirit is superior, as, when staining is employed after subsequent grading into alcohol, there is found to be a lack of differentiation not present in specimens prepared in the ordinary way. As a killing agent, I have, however, successfully employed formalin upon the Gymnoblastic Hydroids, and find that imperfect staining can be obviated by the immediate transference of the animals, after death in the formalin, to an ordinary fixative, with subsequent grading into spirit.

For dissecting and museum preparations, formalin is much more satisfactory than spirit, giving exquisite transparency, very marked in contrast with the dull opacity of spirit-preserved specimens. Specially fine are the fleshy medusæ of the *Sarsia* type, preserved by simple transference, while alive, into the fluid.

For the Calyptoblastic Hydroids, formalin has no special advantage.

ACTINOZOA.—These, as a whole, give excellent results in formalin, provided they be kept in not less than six per cent. strength. For those with very thin-walled tentacles, *e.g.*, *Tealia crassicornis*, a seven per cent. or even an eight per cent. solution is preferable; preparatory hardening in corrosive sublimate is also beneficial, but this somewhat impairs the transparency.

DISCOMEDUSÆ.—The larger medusæ have long been considered well-nigh the most difficult of organisms to preserve satisfactorily. By the employment of formalin, all difficulty disappears, as after a number of experiments this summer I discovered that simple immersion in a five per cent. solution is all that is necessary. To-day, after the lapse of six months, the specimens are as good as, and indeed considerably tougher than, the first day they were placed in the medium. They (*Aurelia* and *Rhizostoma*) are glassy transparent, with the radial canals showing conspicuously in a delicate opalescent white.

The Lucernariidæ—except for histology—should always be preserved in formalin, the results are so good. In this case, previous stupefaction is necessary.

CTENOPHORA.—*Cydippe* and *Beroë* are not satisfactory in formalin; they seem unable to attain sufficient toughness to allow them to sustain their own weight in the fluid.

ECHINODERMATA.—Spirit and formalin are about equal in results.

ENTEROPNEUSTA.—*Balanoglossus* is worthless in formalin, as it secretes too great an amount of mucus, and spirit is necessary to coagulate this.

VERMES.—The Turbellaria can only be preserved in spirit. Nemertines and Polychætes, if previously well fixed, are very satisfactory in formalin, but the use of 50 per cent. spirit fortified with 5 per cent. formalin is even better. Such, however, of the Polychætes as secrete much mucus, *e.g.*, *Chætopterus*, must be preserved in the ordinary way by passing into strong spirit. *Formalin has little or no hardening action upon mucus.*

Some of the smaller Nemertines are killed very well extended by being thrown into formalin.

Rotifers preserve beautifully in formalin if previously fixed in corrosive sublimate.

POLYZOA.—For fleshy forms, such as *Alcyonidium*, formalin is most useful, obviating the dull opacity of spirit specimens.

CRUSTACEA.—For all except those with a well-marked carapace (*Leptostraca*, *Thoracostraca*, etc.), an 8 per cent. solution gives beautiful results, transparency and pliability. Where, however, a carapace is present, this frequently rises, giving an unnatural gap between the posterior margin of the carapace and the succeeding segment. For museum purposes, this is unsightly, but for dissection work there is the counterbalancing advantage of giving the preservative fluid freer admission to the organs beneath the carapace—always a difficult point in the preservation of crustacea.

MOLLUSCA.—Almost without exception formalin is vastly superior to spirit for these animals, and ordinary fixing is quite immaterial—without becoming intensely hard, as they do in spirit, an agreeable firmness, very useful in dissection, is produced. While previous anæsthetising is in no way superseded in the majority of cases, the cephalopods are simply magnificent if transferred direct to a 4 per cent. solution, and I dare prophesy that when once these formalin preparations are seen by our museum authorities there will be a general turning out of the old spirit specimens.

TUNICATA.—Very good and natural results are here obtained if the animals be previously thoroughly stupefied. A weak solution of formalin must be avoided with the delicate species, say anything less than a 6 per cent. strength. *Botryllus* in spirit is a depressing object-lesson of how not to preserve naturally, and though the greater part of the colour fades in formalin, yet the way in which all distortion of the

parts through shrinkage is avoided gives a life-like appearance as satisfactory as any that can be hoped for.

Fishes.—For these a 4 per cent. solution is ample to produce the finest results.

Amphioxus is best killed by plunging direct into the fluid. The result is most beautiful; the natural transparency is so completely retained, that the internal organs can easily be traced, and the buccal cirri protrude gracefully as in life, and not in the state of tangled retraction seen in spirit specimens. Shrinking is quite obviated, and until one can compare a formalin prepared specimen with one fixed and preserved in spirit in the ordinary way, it is impossible to comprehend how much shrunken the latter are.

Elasmobranchs, such as *Scyllium*, are also beautifully preserved for dissection by simple immersion in a 4 per cent. solution of formalin, provided the viscera, heart, and brain be freely exposed by cutting away the abdominal wall and opening the pericardium and brain case. In two days the viscera attain the consistency of gutta-percha. Objectionable smell is quite obviated, the muscles assume a snowy whiteness, and the preparation as a whole becomes so clean and sweet that it is a real pleasure to dissect it. Anyone who has dissected an old-time *Scyllium* can understand what an improvement this means.

Recapitulation of Results.—For histological details, preservation by simple immersion in a strong solution of formalin gives fair results; prior fixation by one of the accepted and appropriate methods gives even better, but both are unmistakably inferior to those produced by fixing and grading into spirit in the ordinary way.

A minor and very useful employment of formalin in microscopical technique is, I find, to add 3 per cent. to aqueous staining fluids, to obviate any chance of the maceration of objects placed therein. Again, it may be employed as a 3 per cent. solution, in place of pure water, in the washing out of ordinary fixatives. I have known many valuable preparations spoiled in the washing out, some by being inadvertently left in too long, and others, again, deteriorated through lack of sufficient washing, due to a fear of possible maceration. By the employment of a formalin washing solution, ample time can be allowed for getting rid of the fixative without the least fear of maceration, as, even if the preparation be left washing longer than intended, the formalin will prevent any ill effects.

For dissecting and museum specimens, simple immersion in formalin solution gives, except in the case of Ctenophora, Turbellaria, *Chætopterus* and allied worms, *Balanoglossus*, and a few others, results not inferior to those obtained by ordinary fixation and grading into strong spirit, while in the majority of cases the results are greatly superior.

Professor de Oliveira believed that formalin would preserve natural colouring little impaired, but my prolonged experiments negative this, for while the loss of colour proceeds much more slowly

than in spirit, still it is but a question of time ere it vanishes. This extraction is most marked and rapid in the highly-coloured sponges and tunicates. Crustaceans, however, retain their colours well.

In addition to the foregoing, I have further experiments with formalin in progress, and trust to present the results at an early date.

Taking every consideration into account, formalin may be regarded, for the majority of purposes, as superior to spirit in the results obtained, and when we remember its greater cheapness—a gallon of strong solution costs on an average but 1s.—and the ease with which we can apply it, it being miscible with water, spirit, and other fluids in any proportion, we may account its introduction as one of the greatest services ever rendered to the working biologist, while to the naturalist in remote places, to whom restricted baggage is a paramount consideration, formalin in its concentrated form will prove an inestimable boon, bringing the formerly unattainable within easy reach—all to the enrichment of our great museums and the advancement of zoological knowledge.

JAMES HORNELL.

SOME NEW BOOKS

Earthworms.

A Monograph of the Order of Oligochæta. By F. E. Beddard, F.R.S. Quarto. Pp. xii., 769, with 5 plates. Oxford: Clarendon Press, 1895. Price £2 2s.

While the reviewer was preparing his work, "System und Morphologie der Oligochæten," he perceived considerable gaps in our knowledge of the morphology of the exotic Oligochæta, and could refer only to E. Perrier's works, which in this respect may be termed pioneer. Simultaneously, however, with the appearance of the reviewer's book, a pleasing revolution in our knowledge of the higher exotic Oligochæta began, to which, among others, F. E. Beddard, Benham, Bourne, Horst, Michaelsen, Spencer, and Rosa have personally contributed. Through the works of these authors we have materially increased our knowledge of the structure of the Oligochæta, and when the reviewer brought out his "Entwicklungsgeschichtliche Untersuchungen," in which, especially, the embryology and organogeny of *Rhynchelmis* and some Lumbricidæ are worked out, the morphology of the Oligochæta was very much more cleared up than can be said of the organisation of the Polychæta, Gephyrea, or even of the Hirudinea. It was only necessary, so to speak, to collect several already published data and facts into a whole, in which all that goes under the name Oligochæta should be placed in a bright light. Beddard took upon himself this work, and in a large quarto volume of 769 pages and 5 plates has sketched an almost complete and correct picture of the organisation of the Oligochæta.

The work divides itself naturally into a general part of 173 pages, and a remaining disproportionately larger part, which is given up to a description of the genera and species. The author has manifestly given only a passing attention to the historical representation. In the following pages I shall endeavour to give a short *resumé* referring chiefly to the general part, while I intend to describe the special part in another place.

The smallest representative of the Oligochæta is *Aeolosoma* (about 1 mm. long), the largest, *Microchæta rappi* and *Megascolides australis* (4 to 6 ft.); the number of the segments varies from 6 to 600. The first segment forms a flap or lobe, the prostomium, which in some forms, as *Stylaria lacustris*, *Rhynchelmis*, and *Rhinodrilus*, is elongated; in others, as in *Deodrilus*, it may be absent. The prostomium, therefore, cannot be regarded as a special segment, especially as the reviewer has shown that it first develops in the embryos supplementarily as a growth of the first segment.

With the exception of *Anachæta*,[1] all Oligochæta are armed with bristles, which rise from the epiblast; in *Anachæta* these are reduced to simple hypodermal glands.

[1] *Branchiobdella*, though generally regarded as a degenerate Oligochæte, is not mentioned in Beddard's work.

The form and variations in their distribution are described in detail by the author. The first segment in all cases is without bristles. In the Geoscolicidæ they are wanting in several of the more anterior segments; in *Kynotus*, for example, there are twenty segments without bristles. A "cephalisation" is caused, partly through this lack of bristles, partly through the absence of dissepiments in two or three of the front segments, and through the development of countless muscles in the peripharyngeal body-cavity. Even the nephridia are deficient or modified in this respect.

Referring to the epidermis, the author cites the well-known relationships of the higher families, and, as in the case of the structure of the clitellum, he refers by name to the works of Claparède, Horst, Mojsisovics, and Cerfontaine, while the communications of the reviewer are not mentioned. Special elements of the epidermis are modified into the sense-cells, particularly in the prostomium[1]; in *Slavina* the sensory elevations are present on each segment. Further, the goblet-shaped organs of the Lumbricidæ, and the sense-girdle in *Rhynchelmis* are described. Also the large gland-like cells in the hypodermis of *Pontoscolex* and *Onychochæta* are held by Beddard to be sense-cells. Finally, Beddard and Horst describe in *Eudrilus* oval bodies in the epidermis in connection with nerves, and compare them to the corpuscles of Pacini.

With regard to the structure of the muscles and their development, the author refers to the works of Cerfontaine and of the reviewer.

The nerve-system shows very primitive relationships only in *Aeolosoma*, while in the rest of the Oligochæta independent cerebral ganglia and a ventral cord are present. The former lie in the first segment in the lower forms, and in the fourth in the higher, where they are at the same time proportionately smaller than in the lower species. The peripheral nerves of the brain are present in varying number; in the Lumbricidæ, as Pisarovic has recently shown, in one or two pairs. Usually it is said that three pairs of nerves proceed from the ventral cord, but according to the data of the last-named author, there are in the hinder segments of *Allolobophora fœtida* only two pairs, the hinder one of which (præseptal, corresponding to the double nerve-segment) stands in a very interesting relationship to the dissepiment and nephridium (=septonephridial nerve). The visceral nerve-system of the Lumbricidæ is so far not known, but in *Megascolides* Spencer,[2] and *Pontodrilus* Perrier, it has been shown. One can feel most secure about this part of the nerve-system in *Chætogaster*, and in the Enchytræidæ, as I have elsewhere shown. The lateral ganglion-cell strings of the lower Oligochæta have lately been declared by Hesse to be unmodified parts of the so-called "nematoid" muscle-fibre. The histological structure of the nerve-system is represented according to the data of Retzius, Friedländer, and the reviewer, and its development according to Wilson, Bergh, and the reviewer.

The lymphoid corpuscles of the body-cavity are thought to be phagocytes.[3] In the cœlom of some Oligochæta special sacs have been discovered, in which the vascular system is enclosed. Beddard calls them "perihæmal spaces," and mentions such in *Deinodrilus*, where

[1] Compare the interesting essay on this matter by Fanny Langdon, *Journ. Morph.*, 1895.

[2] From my own personal researches I can confirm Spencer's data.

[3] Compare the recent communication of Lim Boon Keng "On the Cœlomic Fluid of *Lumbricus terrestris* in Reference to a Protective Mechanism." *Phil. Trans. Roy. Soc. London*, v., 186 (1895), pp. 383–399.

they surround the dorsal vessel. According to Spencer, they are found in *Megascolides*, where a row of diverticula are connected with the body-cavity through a special fissure. Both subintestinal vessels in *Libyodrilus* (Eudrilidæ) possess similar sheaths, as does the supra-intestinal vessel in *Heliodrilus* and *Hyperiodrilus*. These spaces are filled with lymphoid corpuscles, and therefore may represent lymphatic vessels, such as the reviewer has shown to exist also in the sexual-segment of *Allolobophora*.

The pores by which the cœlom communicates with the outer world in Lumbricidæ and some Enchytræidæ have till now remained problematical in function. Beddard describes very closely the excretory organs of Oligochæta. These exist, as the reviewer has shown, in various shapes, according to the stage of evolution of the worm. In the cleavage stage of most Lumbricidæ, three colossal cells function in this manner; the larvæ of the Lumbricidæ possess larval pronephridia; in the segmented embryos, on the other hand, we find embryonic pronephridia. In the first segment the first pair is wanting, which in the Polychæta is known as "head-kidney." These degenerate in Lumbricidæ and *Rhynchelmis*, but Beddard found, on the other hand, that the pronephridia of the first segment of *Octochætus multiporus* persist, and coalesce with the pronephridia of the next segment, forming, in this way, the peptonephridia or salivary glands, which then discharge into the cavity of the mouth. The pronephridia of the next segment and their transformation into the real nephridia or segmental organs, are treated of in my "Entwicklungsgeschichtliche Untersuchungen." With the exception of *Uncinais littoralis* (Bourne), nephridia are known to exist in all Oligochæta; Beddard depicts their form after the classical researches of Benham in *Lumbricus*, as well as the structure of those of *Psammoryctes*. They show the variations of their openings through the contractile vesicle, which last is supposed to be wanting in *Gordiodrilus*. In other respects the nephridia undergo manifold modifications, of which the change of the original paired nephridia to a large number of small, tuft-like excretory organs, which Benham has described as plectonephridia, is the most remarkable.

In the adult Oligochæta the alimentary canal falls into the following parts: the mouth and mouth-cavity, the pharynx, œsophagus, and gut. The mouth-cavity of the Enchytræidæ is worth remark because of the presence of two styles, which the reviewer originally thought to be organs of taste, but which he has lately found reason to believe serve for the digging up of fine roots. In some forms special salivary glands discharge into the pharynx; these were first set down by the reviewer as organs arising from the nephridia (in Enchytræidæ and *Peripatus*). Moreover, the septal glands of the Enchytræidæ discharge themselves into the pharynx; however, these last are known even in higher Oligochæta. The œsophagus of many forms is provided with a gizzard, which usually fills one segment only (in *Lumbricus*, the eighteenth); sometimes, however, several gizzards are present—in *Digaster* and *Dichogaster*, two; in *Perissogaster*, three; in *Moniligaster*, *Heliodrilus*, etc., three to ten. The œsophagus of numerous Oligochæta is provided with calciferous glands, which may be present to the number of from one to eight pairs; in some instances, *e.g.*, Eudrilidæ, etc., they are unpaired, in which case they are related to paired glands, which Michaelsen terms "Chylus-taschen." With the latter the diverticulum from the œsophagus of some Enchytræidæ and *Gordiodrilus* is probably homologous.

The vascular system of the Oligochæta is accurately described.

The author starts from the histological structure of the vessels; he treats first of the chief trunk, namely, the dorsal vessel, which is often paired, and thus retains the embryonic character; next of the supra-intestinal vessel, the ventral vessel, the subintestinal and subneural vessels, and last describes the peripheral circulation with the epidermis-capillaries. Only a few forms possess special respiratory organs, such as *Dero*, *Alma*, *Chætobranchus*, *Branchiura*, and *Hesperodrilus*.

The Oligochæta are all hermaphrodite, and their sexual organs are formed on one and the same plan. The elements present are: (1) the ovaries and testicles; (2) the generative passages, oviduct, and sperm-duct, with egg- and sperm-sacs; (3) the spermathecæ and penial setæ. The position of these varies greatly, but they are always metamerically arranged. Except in *Aeolosoma* the gonads are everywhere paired, the ovaries being present usually in one pair (seldom two), and always situated behind the spermaries. The lower Oligochæta, described by Claparède as "Limicolæ," produce large eggs provided with abundant yolk, while the earthworms possess small eggs ill-provided with yolk. From the latter arise the larvæ swimming in the albumen of the cocoon, while from the richly-yolked eggs come directly segmented embryos (as in Gnathobdellidæ and Rhynchobdellidæ respectively). As to the formation of the egg, compare the data of Horst, Beddard, and the reviewer. The spermatozoa develop completely in special organs, which were formerly described as *vesiculæ seminales*, instead of which the reviewer, for weighty reasons, has proposed the name sperm-sacs. The same function and origin is possessed by the egg-sacs, which are unpaired only in rare cases (Enchytræidæ), but usually present in one to two pairs. Special sperm-ducts are known in all Oligochæta, for in the opinion of the reviewer the statement that *Aeolosoma* discharges the spermatozoa through the nephridia lacks confirmation. The ducts are developed in one or two pairs, and consist of a funnel and a long canal which usually passes into a terminal chamber, the "spermiducal gland." When the sperm-ducts are present in two pairs, they join into a common canal and open outwards through a pair of outlets. One species, called by Beddard *Phreoryctes smithii*, forms an exception; here the four ducts open outwards independently of each other. The originally-described species of *Phreoryctes* (*P. menkeanus* and *filiformis*) are quite unknown in this respect. Special oviducts are not found everywhere; in *Aeolosoma* and Naidomorpha simple openings function as oviducts; these, according to the opinion of the reviewer, correspond to the original funnels, as is the case in Enchytræidæ and Tubificidæ.

With regard to the homology between the nephridia and the sexual ducts, Beddard seems to have superseded E. R. Lankester's old view, according to which each segment contained several pairs of nephridia, one pair of which took upon themselves the functions of the sexual ducts. On the contrary, he turns to the newer developmental researches of the reviewer, according to which the funnels of the ducts proceed from the peritoneum, so that there is no homology between these organs.[1]

As auxiliary organs to sexual intercourse in the various Oligochæte families there are the atria (spermiducal glands, Beddard), the setæ, and the penes, which are all described in detail by Beddard, as are also the manifold relationships of form and position of the spermatophores, of the spermathecæ, of the clitellum, of the sexual papillæ, and of the cocoon.

[1] Compare also Goodrich's last paper "On the Cœlom, Genital Ducts, and Nephridia." *Quart. Journ. Micros. Sci.*, 1895, pp. 477–510.

In the chapter on the geographical distribution of the Oligochæta, the author first describes the factors, which may be the cause of the migrations of the terrestrial forms (our knowledge about aquatic forms is, in this respect, much too scanty). *Allolobophora* and *Lumbricus* belong to the most widespread species, then follow *Eudrilus eugeniæ*, *Pontoscolex corethrurus*, and some species of *Perichæta*. In respect to species, the Nearctic and Palæarctic regions show the greatest similarity. This is also true of the Oriental and Australian forms; here the Cryptodrilidæ and Perichætidæ are the principal forms. The Neotropic and Ethiopic regions are the richest in genera (15, 11), the Oriental and Australian are almost equal, then comes the Palæarctic (4, 5), and, finally, the Nearctic.

Writing of the classification of the Oligochæta, Beddard starts with the comparison of the characters of Claparède's groups, Limicolæ and Terricolæ, with the family Moniligastridæ, and states with justice that these earthworms are a family of the Limicolæ, which, following Benham, he describes as Microdrili. Equivalent to this group are the two remaining Megadrili of Benham (Terricolæ sens. str.) and the Aphanoneura of the reviewer, which division may be deemed a very happy one. That the last-named group of the Aphanoneura takes the lowest place among the Oligochæta—lower, indeed, than the so-called "Archiannelida"—has been already stated by the reviewer. On the other hand, it is very hard to agree with Beddard's view that the Phreoryctidæ represent one of the primitive families of the Microdrili. The chief representatives of this family, *Phreoryctes menkeanus* and *P. filiformis*, are very little known in respect of their sexual organs, and *P. smithi* must perhaps be referred to some other genus than *Phreoryctes*. In the same way, the derivation of the remaining families of earthworms does not seem permissible to the reviewer, especially as the Naidomorpha represent a much earlier group than the rest, from which the Tubificidæ, Enchytræidæ, and Lumbriculidæ can easily be derived. The Chætogastridæ, a very distinct and characteristic family, which at any rate can easily be derived from the Naidomorpha, Beddard, without reason, associates with the latter; and, on the other hand, he gives no reasons why the Discodrilidæ (with *Branchiobdella*) are separated from the system of the Oligochæta. Even the description of the individual genera of Naidomorpha, which are much better characterised than the modern genera of Enchytræidæ, seems to the reviewer not allowable. In this respect—but in this only—Beddard's system will have to be revised; in other respects his book represents a model monograph, which all future workers must consult, whether they intend to work at the morphology of animals or to advance the special study of the Oligochæta.

Prague University. F. Vejdovsky.

A Would-be Legislator.

The Migration of British Birds, Including their Post-Glacial Emigrations as Traced by the Application of a New Law of Dispersal, being a Contribution to the Study of Migration, Geographical Distribution, and Insular Faunas. By Charles Dixon. Pp. 320, with maps. London: Chapman & Hall, 1895. Price 7s. 6d.

Mr. Charles Dixon, or his publisher, is a good-natured man, willing to relieve the reviewer of the tedium of reading his book; for there is inserted behind the title-page an agreeable little printed slip—a skeleton review in which the main points of the book and their importance are pleasantly set forth. We must reluctantly decline,

however, to take the book at the estimate provided, and by the addition of a few complimentary phrases to expand an advertisement into an apparent appreciation. In Mr. Dixon's eyes the great point of his book is that it sets forth a "new law of dispersal." To be brief, this new law is that species never extend their range southwards. It were unnecessary to enter upon a little disquisition as to what a law means, and as to the folly of supposing that a generalisation from facts is any explanation of the facts. Mr. Dixon, we fear, would not understand us; and we should be performing a task unnecessary in the case of most of our readers. A single quotation, from many hundreds that might be made, will show that Mr. Dixon is really making this elementary mistake. He writes (p. 57) "we need no 'persistence through long epochs of barriers, isolating the greater part of Africa from the rest of the world,' as Dr. Wallace insists, to account for the absence of such groups as bears, moles, camels, deer, goats, sheep, or such genera as *Bos* and *Sus*: a law forbidding the southern emigration of such types is sufficient to explain the facts, without invoking more or less hypothetical geographical obstructions." Cannot Mr. Dixon see, even if he had succeeded in showing completely that southern dispersal never does, or never has, taken place, that we should have found out no more than a very interesting circumstance to be explained? Dismissing, however, as unworthy of notice what Mr. Dixon considers the point of his book, we shall find in it a very judicious selection of facts and arguments in support of the view that the dispersal of species has taken place in a northerly direction. In the earlier part of his book he concedes so much to common-sense as to endeavour to find a rational basis for this absence of southerly dispersal. He holds that species do not retreat from unfavourable conditions, at least in the ordinary sense of the word. When the Glacial period came on, the inhabitants of the ice-covered regions were simply exterminated. Only those species survived which had a range extending far enough south to avoid the ice. The rest of the species were, so to say, wiped off the slate. He thinks that there were three great "refuge-areas," or "range-bases," for inhabitants of North Europe during the periods of glaciation. The northerly limit of one was the extreme southern edge of the ice, and it extended across the English Channel, then dry, and along France to the ice of the Alps and the ice of North Spain. It was a land similar to the inhabitable Arctic regions of to-day. The second refuge-area extended from south of the first to the Sahara Sea. In this region, probably, most of the birds now in England were preserved. The third area was to the south and east of the second, extending down the Soudan to the Cape. In it were preserved a smaller number of contemporary English species—those chiefly with very wide and eccentric ranges of migration to-day. All birds, thinks Mr. Dixon, which bred north of these refuge-areas, were exterminated by the glaciation. All the birds of existing North Europe have appeared there by a post-glacial, northern extension of their breeding-grounds.

Here is the whole subject-matter of Mr. Dixon's book; and by a vast array of facts and discussions of existing distributions and migrations he attempts to support it. The maps and the facts are both useful, and, as every intelligent reader will see that the "law" part of the book is pure nonsense, we may honestly commend the rest to discriminating persons. But we must admit that even such will find the continual irruptions of the law very distracting, and rather adapted to make them throw the whole thing aside.

A Manual of Ethnology.

The History of Mankind. By F. Ratzel. English edition. In thirty monthly parts (1s. each). Parts I. and II., Oct. and Nov., 1895. Macmillan & Co.

One of the greatest desiderata in the literature of natural science in England is a reasonably complete modern manual of ethnology. The English text-books on this subject have long since been hopelessly out of date, and students have had to rely on foreign works, and notably on Professor Ratzel's "Volkerkünde (three vols., Leipzig, 1887–1888). This work consists of a long introduction devoted to the principles of the science, after which it gives an account of the ethnography of Africa, of Asia and Australasia, and then of the Americas. Professor Ratzel's work is marked by a thorough acquaintance with the literature of the subject, and it supplies a remarkably complete abstract of existing knowledge. It is an indispensable book of reference to every student of ethnology, and it has long been a matter of regret that the absence of an English translation rendered it inaccessible to a large proportion of British travellers. We are glad to find that this want is now being supplied by Messrs. Macmillan, who are publishing a translation in monthly parts. The illustrations, which are an important feature in the original, are being admirably produced; and as the paper and printing are better than the German, the work is in some ways an improvement. So far as we have tested the translation, it is accurate; but the English might easily be improved, as it is often so literal as to be awkward and confusing. "Thus Herder"—as a complete sentence, is rather too Teutonic. "Out of 570,000,000 estimated of monotheists, 440 confess Christianity. Of the remaining 900,000,000 of the earth's inhabitants, the Buddhists, with 600, occupy the largest area, and the most inaccessible to Christian teaching"—is not a model of precise English. "And besides that, the emitted light of faith radiates back warmth"—is not very lucid. This is not the sort of English that we expect from such a well-known writer as Mr. A. J. Butler. As so little trouble is taken over style, it is needless to say that the matter has not been brought up to date. Ratzel draws a large percentage of his illustrations from Africa, where the progress of research is so rapid that many statements made in 1886 are now absurd. Thus on pp. 91 and 95 there are figures of women belonging to the tribes of the Nyam-nyam and of Unyoro, and the remark is retained that "the lady of Uganda or Unyoro. . . . stands in general no higher than the Nyam-nyam negress." The illustrations show differences in physiognomy which alone might have suggested doubts of this view, and recent information shows that it is far, indeed, from the truth. Moreover, some of the terms are used with such different meanings from those accepted for them by English ethnologists, that they cannot but confuse English readers; and it is a pity that they were not explained in footnotes. The editor contributes a few suggestions on general questions, but these are not a valuable addition to the book.

A Guide to the Rocks.

An Introduction to the Study of Rocks. British Museum (Natural History), Cromwell Road, London, S.W. Mineral Department. Printed by order of the Trustees. 8vo. Pp. 118. London, 1895. Price 6d.

The Department of Minerals of the British Museum, of which department Mr. Lazarus Fletcher is the head, has identified itself with practical education of the best kind. This is the third so-called

guide-book to its collections that has appeared. As in its well-known predecessor, "The Study of Minerals," Mr. Fletcher has struck out an entirely original line. Those who expect to find in this book merely the cheapest text-book of petrology that they can purchase to prepare themselves for some elementary examination, or even to give themselves a sound knowledge of the necessary facts and figures of the science, will be disappointed. Shortly to characterise the plan of the book, we should say that it provided an introduction to the methods of all science, especially to those departments of science that concern themselves with the orderly arrangement or classification of things or facts, and that the study of rocks was brought in rather as an illustration of scientific methods than as the principal aim of the book. Perhaps this would be going a little too far, for there can be no doubt that whosoever chooses to master this little book will also have gained no inconsiderable acquaintance with the facts and principles of petrology. Roughly put, the author's method in this guide is to set before the student a miscellaneous assortment of rocks, and to ask him to classify them. The incorrectness and impracticability of the classifications that at first suggest themselves from such superficial characters as colour, texture, or weight is exposed, and the student is then initiated into the various means of investigating the inner structure, the affinities, and the modes of origin of rocks, and so has placed before him—clear to his understanding, though as yet unattainable—the ultimate goal of a natural classification. Although the book is of interest and even of value when taken by itself, yet its real worth will not be apparent until it can be read in connection with the splendid series of teaching specimens that the Department is gradually accumulating and now beginning to arrange in the table-cases adjoining those that contain the series introductory to the study of minerals. The book is in fact what it professes to be—a Museum Guide. Not indeed a description of exhibited specimens, or a barren list of more obscure treasures, but a book that should enable every intelligent person to proceed for himself to the true appreciation of the contents of one section of our great Museum.

For those who wish to acquire knowledge, the British Museum is fast becoming more than a mere storehouse, and it will be to the teaching collections more than all else that the growth of the scientific collections will be due in the future. We congratulate Mr. Fletcher and his assistants, Messrs. Miers, Prior, and Spencer, on the thoroughly practical arrangement of the collections under their charge.

THE GEOLOGY OF IRELAND.

GUIDE TO THE COLLECTIONS OF ROCKS AND FOSSILS BELONGING TO THE GEOLOGICAL SURVEY OF IRELAND, arranged in Room III.E. of the Museum of Science and Art, Dublin. By A. McHenry, M.R.I.A., and W. W. Watts, M.A., F.G.S. Dublin (for her Majesty's Stationery Office): Alexander Thom and Co. Price 9d.

DESPITE the publications of the Mineral Department of the British Museum, fraught with such originality and freshness, and the admirable treatises on art issued under the auspices of the South Kensington Museum, it appears that there is still room for surprises among official handbooks. Messrs. McHenry and Watts, in place of a dry catalogue, have produced a manual of the Geology of Ireland which will be even more valuable to those engaged in research than to the ordinary visitors in the museum. The rocks collected by the

Geological Survey of Ireland have for some years been arranged, according to geographical areas, in upright cases in a room of the Dublin Museum; while the fossils have been displayed in table-cases associated with them. The arrangement of these flat cases is, of course, stratigraphical, and the figured and type-specimens have been removed to a special collection. The geology of the country has been further illustrated by a series of the one-inch maps of the Survey hung in the upright cases, so as to correspond with each geographical group of rocks, and by photographs and water-colour paintings, exhibited to such advantage or disadvantage as the lighting of the building will permit. To crown their labours, Mr. McHenry, who chipped out so many of the specimens with his own hands, and Mr. Watts, who for a time had charge of the petrographic investigations, have drawn up in an unpretentious form a systematic account of the collections.

Both the petrological and palæontological portions of this guide show evidence of regard for recent literature, and the former section has afforded scope for many original observations. Workers, intent on elucidating some one of the local problems of Irish geology, will again and again find that they have been anticipated by the careful but comprehensive work of Mr. Watts; while Mr. McHenry has long possessed a capacity for attacking difficult areas and bringing home a mass of useful information. An index of localities would have improved the present guide as a work of reference; but it will at once take its place in the library and not only as a guide to the museum.

While the petrological portion presupposes a certain amount of geological knowledge, and even a familiarity with some of the generic names of rocks evolved in German laboratories, an attempt has been made to preface the palæontological pages by an outline of the animal kingdom. This, we think, is a mistake, especially as there is a well-equipped department of zoology close at hand. It would be ungracious to criticise details where so much compression of material has been effected; but some revision may be possible in a new edition. Thus (p. 99) the occurrence of corals in the American *Olenellus*-fauna is overlooked; nor can an ophiurid be aptly described as "pentagonal in outline." On page 101, we read "the Eurypterids were large crustaceans, most of whose abdominal segments were devoid of limbs." There is, moreover, a great vagueness in the reference to the King-crabs; whether the concluding sentences refer to *Limulus* or to the Limuloids, one or other of the statements made must be incorrect. On p. 116 we may quarrel with the description of *Asterophyllites;* but slips and misprints are delightfully rare throughout the work.

Full use has been made of the most recent researches on Irish geology, although space would not permit of reference to more than the authors' names. But the work of Messrs. McHenry and Watts, in the field and in the office in Hume Street, has contributed a host of new details, which appear here in the most modest manner. As an example of the skilful treatment, on the other hand, of a mass of older information difficult to correlate, we may cite the description of the Old Red Sandstone in Munster, on pp. 83–85.

This little paper-covered volume, the price of which is a few pence, not shillings, is unquestionably the best informed work on Irish geology extant. It is not a museum-catalogue, but a readable guide, indispensable to those who would have an accurate knowledge of the stratigraphical geology of our islands. G. A. J. C.

Atlases.

Philip's Systematic Atlas. Physical and Political, specially designed for the use of High Schools and Private Students, etc. By E. G. Ravenstein. School Edition, 11 × 8 inches. 41 double pages containing 170 maps and diagrams and an Index of 12,000 names. London: G. Philip & Sons, 1894. Price 10s. 6d.

Philip's Handy-volume Atlas of the World. By E. G. Ravenstein. New and enlarged edition, 6 × 4 inches. 72 maps and Index. London: G. Philip and Sons, 1895. Price 5s.

In April, 1894, we had something to say about the first of these atlases, and though our remarks may not have been pleasing to the compilers or to the publishers, they might well have been listened to for reputation's sake. The School Edition of the Systematic Atlas, it is true, omits the nonsensical geographical distribution map as well as the inadequate geological map of Europe; but it includes the absurd little hemispheres of religion, and those showing the races of mankind. "Tit-bits of inaccurate folly" we called them then, tit-bits of inaccurate folly we call them now. We have no good word for publications in which absurdities once pointed out are persistently reproduced, even though Messrs. J. Scott Keltie, H. J. Mackinder, and E. G. Ravenstein vouch for their accuracy. We hope this atlas was not exhibited at the Geographical Congress for the delectation of our foreign visitors.

The Handy-volume Atlas, with its seventy-two maps, is much more useful. It seems to have been brought up-to-date carefully, and is clearly printed, and not overcrowded with names. The impertinence of classifying religions into *Heathen*, Hindus, Bhuddists, [*sic*] Mohammedans, and Christians is repeated, but the races of mankind here fall into the following heads: Aryans, Semites and Hamites, Mongols, and American Indians, though others are shown in the two little hemispheres. On the backs of each map is printed a variety of information of use for reference, and there is a good index.

Cats.

A Handbook to the Carnivora. Part I. By R. Lydekker, F.R.S. Allen's Naturalist's Library. Edited by R. B. Sharpe. Pp. viii., 312, with 32 plates and woodcuts. London: Allen & Co., 1895. Price 6s.

Dr. Sharpe, the editor of the series, has wisely entrusted to Mr. Lydekker the preparation of a large number of the mammalian volumes of the Naturalist's Series, a task for which he is well fitted by reason of his special acquaintance with the group and his phenomenal fertility in the production of results. We imagine that there are few writers upon zoology who can show so magnificent a total in the way of published work as can Mr. Lydekker. So far as we can judge of the present volume, we cannot accuse the author of having sacrificed accuracy to speed. His clear descriptions are borne out by plates which we cannot actually term excellent, but which are fair representations of the animals which they illustrate; but in making this criticism the low price of the book must obviously be taken into consideration. For our part, we would have preferred fewer and better pictures; but that is a matter of taste concerning which there might be disputes. The figure of the *Cryptoprocta*, for example,—which we are glad to see Mr. Lydekker includes without any fuss among the Viverridæ, a proceeding in which he is supported by Mr. Beddard in his memoir upon the anatomy of the animal published in the last number of the *Proceedings* of the Zoological

Society,—contrasts unfavourably with the beautiful coloured drawing of the Fossa from the pencil of the well-known animal painter, Mr. Nettleship, which adorns Mr. Beddard's paper. Still, we cannot expect everything for six shillings, and the wonder is what a great deal the publishers have given us for that modest sum. If the editor could be induced to urge Messrs. Allen to treat of the invertebrates in the same liberal and thorough fashion in which the vertebrates are being treated, the Naturalist's Library would be a work without which no naturalist's library would be complete.

Animals of the Coast of Normandy.

Recherches sur les faunes marines et maritimes de la Normandie. Par H. Gadeau de Kerville. Pp. 184, with 2 plates and 4 woodcuts. Paris: Baillière. Price 5 francs.

This is a careful faunistic list of the coasts of Normandy, preceded by a bibliography—large in itself and terminated by an "etc."—of the author's works. Maps as well as figures of animals constitute the plates, while the author apparently neglects no group, but includes the land vertebrates as well as the marine invertebrates. A special feature of the work is an appendix upon the copepods of the region by E. Canu, and upon the mites by E. L. Trouessart, in which latter report the anatomy of several species is gone into at some length.

Recent Writings on the Foraminifera.

The Zoological Society has just published (*Proceedings*) an important paper by Mr. Frederick Chapman "On some Foraminifera obtained by the Royal Indian Marine Survey's s.s. 'Investigator' from the Arabian Sea, near the Laccadive Islands." The area from which the material was obtained is sufficiently out of the path of former expeditions to make the list useful. The samples were dredged from a depth not exceeding 1,238 fathoms. Exact depths were not recorded, but the temperature at 1,130 fathoms was 37° F., while that at the surface was 78°–80° F. Two hundred and seventy-seven species are noted, of which eight are new to the list of recent forms. These eight were recorded by Schwager for the Kar-Nicobar Pliocene clays (Novara Exped., Geol. Theil ii., 1866), and we are now enabled, with the assistance of Brady's Monograph, to compare very closely the foraminiferal fauna of these Pliocene deposits with that of the present surrounding sea. An interesting point too, in Chapman's paper is the canal system described in *Amphistegina radiata*, and this and other features mentioned in the paper, strengthen the evidence in favour of this form being truly referred to *Amphistegina*. Another point of even more interest is the section of *Amphistegina* showing a young shell in one of the chambers.

Dr. V. Madsen, of Copenhagen, continues his work in recording occurrences of Foraminifera from the Pleistocene beds of Rügen and West Prussia (*Med. Dansk. geol. Foren.*, 3); Dr. F. Karrer, in a further paper on the Tertiary beds of the Vienna basin (*Jahrb. k. k. geol. Reichs.*, 1895), carefully lists the occurrences in the various clays and sands that have come under his observation; G. A. De Amicis has published (*Nat. Sicil.*, xiv., 1895) a valuable paper on the Foraminifera of the Pliocene beds of Bonfornello, in Sicily. One hundred and sixty-three forms are enumerated, of which several are new; one plate is given. There is an interesting new *Cyclammina*, while *Ramulina* is recorded for the first time from Pliocene deposits. Carlo Fornasini contributes to the *Memoria R. Acc. Sci. Bologna*, vol. v., a continuation

of his notes on the Italian Tertiary forms, dealing with the Frondiculariæ and Cristellariæ in particular. He figures a large series of the compressed varieties of the *C. cymba* group. In a single sheet, privately printed, Fornasini describes *Lagena felsinea*, an entosoleniform *Lagena*, in which the test is botelloid and the aperture lateral.

Besides these recent papers, there are two which were published in 1892 by Jaroslav Perner, of Prague, which appear to have escaped notice on account of their inaccessibility. The first is "Predbezny kriticky seznam Foraminifer z brezenskych vrstev," and was published in *Vestnik Krakovske Ceske Spol. Nauk*, 1892, at Prague. This is an account of the forms found in the Priesener Beds of the Bohemian Chalk, and is valuable for comparison with Reuss's list of the same district, and with those of other Chalk deposits. The other paper is entitled "Ueber die Foraminiferen des böhmischen Cenomans," and will be found in the quarto publications of the *Ceska Akademie Cisare Frantiska Josefa* (Trida ii.) under the Czech title, "Foraminifery Ceskeho Cenomanu." With this paper are published a series of ten excellent plates, which contain a number of valuable sections. The author has evidently been handicapped by the absence of previous literature in Prague, but in the future this want can easily and willingly be supplied by his English colleagues. Borings of parasitic organisms are shown in many of Perner's figures, and what is apparently an aperture of *Ramulina* is seen on pl. 5, fig. 19*b*.

Photograms.

We are really indebted to the editors of *The Photogram* for sending us their beautiful annual "Photograms of '95. A Pictorial and Literary Record of the Best Photographic Work of the Year" (Dawbarn & Ward, Ltd.). It contains beautiful examples of photography, of half-tone process, and of printing. Especially are we struck by the absurdly-named "Chemigraph" process, which consists in printing two or three impressions from the same block—one in a strong body colour, and the other or others in a pale tint, and very slightly out of register. Some of the photograms from abroad are a little older than the title of the volume warrants—at least, the pretty picture of some Japanese women on the balcony of a tea-house in Tokio has a familiar aspect. "The photographic study of animal life has," we are told, "been greatly advanced. A. G. Wallihan and his wife in Colorado, and W. H. Wright in Montana, have added considerably to their invaluable studies of the fast-disappearing native fauna of the United States; and J. Turner-Turner has published his intensely interesting records of hunting, trapping, and natural history in Canada." In our own country, not to mention Mr. Gambier Bolton, some of the chief workers are R. B. Lodge and R. and C. Kearton, who have devoted themselves to birds and their nests. Workers in natural science will also be glad to hear of the cyclograph, an instrument invented by A. H. Smith, of the British Museum, to take a view all round a circular object. We wish that we could treat of some of the photograms, such as E. Calland's wonderfully composed and lighted "Brompton Road—Late Afternoon," F. H. Evans' restful and exquisite "Stairway in Lincoln Cathedral," or "Harvesting Osiers," by A. J. Jeffreys. This our scope does not permit, but we should be failing in our duty did we not inform the bewildered critic that the "streak of light in the centre of" C. Millard's "After Lessons" is clearly a microscope tube, which interpretation is confirmed by the condenser alongside. In short, this is a well written, well illustrated, and cheap two shillings-worth.

OBITUARY.

ROBERT BROWN.

BORN MARCH 23, 1842. DIED OCTOBER 26, 1895.

ROBERT BROWN ("Campsterianus"), the well-known botanist and editor of popular works on science, was born at Campster, Caithness. He was educated at Edinburgh University, and in later life visited Leyden, Rostock, and Copenhagen for educational purposes. At Rostock, he read his thesis "Species Thujæ et Libocedri quæ in America Septentrionale gignuntur." From 1860 to 1875 Dr. Brown was a great traveller, visiting Jan Mayen, Spitzbergen, and Greenland in 1861; the West Indies, the Pacific, Vancouver, and Alaska in 1863–66 as botanist to the British Columbia Expedition; Greenland in 1867, in company with Mr. Whymper; and after 1868 he travelled in Northern Africa. He was the author of numerous papers, but the public will remember him best by his editorship of "Peoples of the World," the "Story of Africa and its Explorers," and "Science for All."

THE HON. WALTER B. D. MANTELL, son of Gideon Algernon Mantell, and himself a geologist of considerable merit, died at Wellington, New Zealand, on September 7. Mr. Mantell was born in 1820, but left England for New Zealand about 1840, where he became a man of great public importance, holding the posts of Minister for Native Affairs and of Postmaster-General and Secretary for Crown Lands. He was ever mindful of the interests of the Maoris. Mantell was the first to explore the Waikonaiti and Waingongoro Moa beds, and his collections ultimately found a resting-place in the British Museum. He retained to the end his interest in geology, and possessed many specimens that had belonged to his father, some of them possibly of historic interest.

ABRAHAM VIKTOR RYDBERG, who died at his home near Stockholm on September 21, at the age of 67, was not merely the greatest writer both in prose and poetry that Sweden has known since the days of Tegner, but a learned authority on the history and development of art and culture. It is chiefly through his researches into the myths of the Teutonic peoples that he is known to the narrower

scientific world. His great work on the subject gave rise to much discussion among specialists, and a translation of it by R. B. Anderson was published in London in 1889, under the title "Teutonic Mythology." The last writing from his pen was an essay on the future of the white race, prefixed to the Swedish translation of Mr. Kidd's "Social Evolution." Himself an earnest student, a friend of science, and, while member of the Riksdag, a promoter of scientific education, it was nevertheless his life-work to protest against a cold, materialistic interpretation of nature, and to set before the younger generation the half-forgotten claims of the ideal.

AMONG other deaths which it is our misfortune to record, are those of: PHILLIP HENRY LAWRENCE, the mineralogist, and translator of von Cotta's treatise on Lithology, who died towards the end of October; Professor H. HELLRIEGEL, the agricultural chemist, director of the agricultural experiment station at Bernburg, best known for his discovery of the fixation of free nitrogen by leguminous plants, by the micro-organisms in the root nodules, who passed away on September 24, aged 64; DR. ERNEST BAUMANN, the African traveller, at Cologne, on September 4, at the early age of 24; EPHRAIM W. BULL, the agriculturist, on September 26, aged 89; Professor F. BERTÈ of Catania, on September 9; J. KOSTAL, malacologist, and assistant in the Bohemian Polytechnicum, on September 26, at Prague; DR. E. SLIZENBERGER, lichenologist, at Constance, on September 27; the aged student of Lepidoptera, J. FALLOU, in Paris, on June 19, in his 84th year; Dr. RIVA, botanist and African traveller, in Rome, on August 24; Dr. GUSTAV WILHELM, Professor of Agricultural Botany in the Technische Hochschule at Graz, on September 30; P. BERTKAU, Professor of Zoology at Bonn; Professor L. DUDA, student of Hemiptera, in Prague, last August; and Dr. JAS. E. GARRETSON, dean of the Philadelphia Dental College, on October 27, aged 67.

OUR readers will find a portrait and a full and appreciative account of the life and work of the late Professor C. C. BABINGTON in the September number of the *Journal of Botany*, by the editor; and in the *Botanical Gazette* for August a biographical sketch by G. E. Davenport, also with a portrait, of another botanist, DANIEL CADY EATON, of whom we published a short obituary notice in our September number.

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

THE following appointments are announced:—Dr. Marshall Ward, Professor of Botany at Cooper's Hill Engineering College, to be Professor of Botany at Cambridge in place of the late Charles Babington; James Wilson, Lecturer in Agriculture at Aberystwyth, to be Fordyce Lecturer in Agriculture at Aberdeen University; F. F. Blackman, Demonstrator of Botany at Cambridge University, to be a Fellow of St. John's; V. H. Blackman, to be Assistant in the Botanical Department of the British Museum; M. D. Hill, to be Junior Demonstrator in Zoology at Owens College; Thomas Midgley, son of the Curator of the Chadwick Museum, Bolton, to be on the permanent staff as Assistant-Curator and Taxidermist; Dr. F. Marés, to be Professor of Physiology at the Bohemian University, Prague; J. Gad, to be Professor of Physiology and Director of the Physiological Institute in the German University, Prague; Dr. M. von Lenhossek, of Warzburg, to be Prosector in the Anatomical Institute at Tübingen; Dr. Joseph Disse, of Halle, to be Professor of Anatomy at Marburg; Dr. Beck, of the Geological Survey in Leipzig, to be Professor at the Mining College of Freiberg, i.S.; Dr. Hillebrand, to be Assistant-Professor of Experimental Psychology at Vienna; Dr. Schuchardt, to the newly-founded Professorship of Psychiatry at Rostock; Dr. J. Wortmann, Director of the Experiment Station in Plant Physiology at Geisenheim, to be Professor; Dr. A. Rothpletz to be Extraordinary Professor of Geology and Palæontology in Munich University; Carl A. Redlich, as Curator of the Brünn Museum; Dr. Dogiel, Professor of Anatomy at Tomsk, to be Professor in the University of St. Petersburg; Professor F. Ficallei, of Cagliari, as Professor of Zoology at Messina; Daniel F. MacDougal, to be Assistant-Professor of Botany in Minnesota University; H. Landes to be Professor of Geology in the Washington State University; Richard E. Dodge to be Instructor in Geography and Geology in the Teachers' College, New York. Dr. Albert Mann has taken up work in Biology at the Ohio Wesleyan University. Dr. W. Biedermann has gone to Graz University.

THE Burdett-Coutts' Scholarship in Geology, of Oxford University, has been awarded to W. B. Prowse, of Pembroke. R. M. Brydone, of New College, has been awarded the Scholarship which was not given last year, tenable for one year only.

A CURATOR is to be appointed for the Fielding Herbarium at Oxford. He will be under the Professor of Botany, and will be paid by income arising from a bequest of £900 under the will of the late Mrs. Fielding, and from other funds at the disposal of the Fielding Curators.

MINNESOTA UNIVERSITY is building a laboratory for bacteriological, histological, and pharmacological research.

THE late Sir Jerome Murch bequeathed £50 to the Bath Literary and Scientific Institution, of which he was sometime president. Colonel Chase has left

5,000 dollars to Harvard College, to found a medical scholarship, to be called the C. B. Porter Scholarship. The Spring Garden Institute, of Philadelphia, has received a gift of 100,000 dollars from the heirs of Samuel Jeanes, himself a great benefactor during his lifetime. Earlham College, Richmond, Indiana, has received from Messrs. M. H. and F. T. White, of Cincinnati and New York, 25,000 dollars as a memorial of their father, John T. White. The Royal College of Physicians of London has received £3,000 from Dr. H. Weber, to found a triennial prize for research on the prevention and cure of tuberculosis. Mrs. Mary Putnam Bull has given to the Davenport Academy of Natural Sciences ten thousand dollars in memory of C. E. and J. D. Putnam. This sum will ensure the continued publication of the valuable *Proceedings* of the Academy.

SOME of the work done this year at the Marine Laboratory of the U.S. Fish Commission at Wood's Holl is summarised in *Science* for October 25 by Professor J. I. Peck. H. V. Wilson has studied the sponges from the Gulf of California and the Galapagos Islands, collected by Agassiz on the "Albatross." W. Patten has investigated some abnormal developments of *Limulus* embryos, which are expected to throw light on the physiology of embryonic growth. L. Murbach has had the luck to obtain the eggs of the medusa *Gonionemus* in various stages of development, while G. Lefevre has made interesting observations on the fixation of the tailed larva of *Perophora*. Important work on nervous systems, and specially on ganglion cells, has been conducted by I. Van Gieson, I. Strauss, J. E. Peabody, and others. T. H. Montgomery has studied the histology of nemertines and the development of their proboscis. Professor Peck himself has found out what the youngest fish-fry feed on. He concludes with some remarks, which specially appeal to us, on the relations of the Laboratory to educational bodies. The work of the young students, he says, "seems more important each year than it did the year before." Since no definite instruction is given at the Laboratory, such students should be furnished in advance with "definite ideas of what forms to select for work, how to proceed, and what to read." "An advantage of the presence of students who are doing work of a more general character is the custom of regular towing, and of constantly bringing into the Laboratory fresh supplies of living material of many kinds. . . . This keeps all the men engaged in special research in association with general phenomena of the most attractive kinds." The collection of material by teachers for class demonstration has also greatly benefited "biological work in all of the twenty universities, colleges, and secondary schools represented here this season."

MR. ANDREW CARNEGIE has, at a cost of £200,000, built a free library, with museum, art galleries, and four branch libraries, at Pittsburg, U.S.A.

THE Owen Memorial Committee has decided that the statue to Owen, to be placed in the British Museum (Natural History), shall be in bronze.

THE changes at the British Museum (Natural History) on the retirement of the Keeper of Zoology, Dr. A. Günther, are as follows:—Professor Sir W. Flower assumes the office of Keeper of Zoology in addition to his post as Director, without addition of salary; Dr. Bowdler Sharpe becomes Assistant-Keeper of Vertebrata, his department consisting of Messrs. Thomas, Boulenger, and Grant; Mr. Edgar A. Smith, Assistant-Keeper of Invertebrata, associated with Professor Jeffrey Bell, Mr. Pocock, and Mr. Kirkpatrick; Dr. A. G. Butler, the head of the Entomological Department, with his juniors, Messrs. Waterhouse, Kirby, Gahan, Heron, Austen, Hampson, and a new Assistant appointed to fill the vacancy. Mr. Pocock becomes a first-class Assistant. Changes have also been begun in the galleries. For instance, the larger fishes will be slung up to the roof, so as not to cumber the valuable floor-space, and a more definite arrangement will be made of fishes; similar alterations are contemplated in the reptile gallery, where seventeen crocodiles have for many years enjoyed palatial quarters on the floor. The public gallery

of birds will gradually be improved on the plan adopted already in one of the bays, and in the mammalian gallery certain arrangements are contemplated which will show the finer specimens to great advantage.

The Trustees have recently purchased for the Department of Geology important series of fossils selected from the collections of the Rev. P. B. Brodie, Rowington, Warwick, and of the late Mr. James W. Davis, Chevinedge, Halifax. Mr. Brodie's collection, the result of a long and active life devoted in all intervals of leisure to geological work, comprises a large number of type-specimens described by various authors; and all of these are included in the British Museum selection except those in his unique cabinet of fossil insects, which he still retains. The collection of the late Mr. Davis contains some very fine fishes from the Lower Lias of Lyme Regis and a large number of fragmentary fish-remains from the Yorkshire Coal-measures, described and figured in his own writings.

Mr. Oldfield Thomas, whose health for some time has been unsatisfactory, has received six months' leave of absence, for an extended foreign tour. Mr. E. E. Austen has also received four months' leave from the British Museum in order to join a cable expedition of Messrs. Siemens up the Amazon. We look forward confidently to the time when every man on the staff will be sent out, not on leave, but officially, for the purpose of studying foreign collections and life in the field.

We are glad to note that the Treasury has generously decided to present a complete series of the "Challenger" Reports to the Bristol Free Public Museum. This is a graceful recognition of the valuable educational and scientific work now being carried on by that museum, which has made remarkable progress since it came under the control of the City Corporation.

Popular lectures are, as usual, being given at the Manchester Museum. W. E. Hoyle lectures on Geology, F. E. Weiss on Botany, Boyd Dawkins on Geology, Burghardt on Mineralogy, and S. J. Hickson on Anthropology. These lectures are aided by an annual grant of £400 from the Corporation of Manchester, drawn from the Free Library rates.

We have received from Mr. Hoyle another of the useful museum handbooks. This is a "Catalogue of the Hadfield Collection of Shells from Lifu and Uvea, Loyalty Islands," by James Cosmo Melvill and Robert Standen (price 1s.), and it is nothing more or less than a reprint, retaining the original pagination and plates, of a paper published by those authors in the *Journal of Conchology*. So long as proper references are given and dates not tampered with, we have nothing to say against such a form of re-publication. Indeed, if proprietors, editors, and authors are willing, we see no reason why this useful course should not be followed by other museums. Many papers are published, and readers of Natural Science especially can call to mind no few such, that would be most acceptable to the public if reprinted and sold by museum authorities at a small charge.

The Epping Forest Free Local Museum, established by the Essex Field Club, in Queen Elizabeth's Lodge, Chingford, was opened on November 2 by Mr. R. C. Halse, Chairman of the Epping Forest Committee of the London Corporation. There was a large attendance of members of the Club, and Sir William Flower, Director of the British Museum (Natural History), was among the invited guests. In the evening a formal meeting was held in the Royal Forest Hotel, and Mr. A. Smith Woodward delivered an appropriate address on Local Museums. The Essex Field Club, as is well known, has already established a County Museum at Chelmsford; but it has long urged the importance of a smaller museum within the Forest area, and all difficulties in the agreement with the Committee of the London Corporation have at last been overcome. This new museum is established mainly to serve two purposes, namely (1), to afford plain information about the animals, plants, geology, and antiquities of the district, and so promote a love for the out-of-door study of Natural History among the intelligent visitors to the Forest, and (2) to form

ultimately a store-house for the preservation of authentic series of Forest specimens, not only as a matter of scientific importance, but also as aids to the studies of the many amateurs who frequent the Forest as one of the best "all-round" hunting grounds for the naturalist in the London district. With the permission and enlightened recognition of the usefulness of such an exhibition by the Epping Forest Committee of the Corporation of London (who have met the wishes of the Club in the kindest way), the collections have been housed in the Banqueting-room of the antique building known as "Queen Elizabeth's Hunting Lodge," which was transferred by the Crown to the Corporation at the passing of the Epping Forest Act, to be preserved "as an object of antiquarian interest." The arrangement of the cases has been admirably carried out by Messrs. W. and B. G. Cole, with the co-operation of an enthusiastic Committee, and an interesting series of specimens is already displayed. Mr. T. Hay Wilson has contributed a small collection of rock-specimens from the gravels of the Forest area, and derived fossils from the Boulder Clay. Mr. J. E. Greenhill has a series of bones of mammals and shells of molluscs from the surface deposits of the Lea valley, also numerous stone and bronze implements. The investigations of the Essex Field Club itself have provided late Celtic objects from the Ambresbury and Loughton Camps. Mr. Chalkly Gould has arranged a collection of Romano-British pottery, etc., from Chigwell, which is described in the first of a proposed series of Museum Handbooks. A collection of dried fungi, made by the late Mr. English, of Epping, occupies a wall-case; and near it is a valuable volume of about 500 coloured plates of fungi by Dr. M. C. Cooke. The flowering plants collected and dried in an uncrushed state by the late Mr. English occupy numerous cases, and large plates of dissections from Oliver's "Botany" are conveniently placed near them. The insects are mainly from the collections of Messrs. W. and B. G. Cole, while the land and fresh-water shells, beautifully mounted, have been contributed by Mr. W. Crouch. An almost complete collection of the eggs of birds nesting in the Forest is exhibited, and the birds themselves are not only represented by many actual specimens, but also by a series of woodcuts from Saunders' "British Birds." On the staircase are shown some interesting maps and various views of the Forest. The museum is open to the public each week-day, and all communications respecting it should be addressed to Mr. William Cole, the Honorary Curator.

WE understand that the Belgian Government, not satisfied with the extent of its new Royal Museum of Natural History, is already contemplating the addition of a special gallery for the reception of the unique series of Iguanodons and other fossil vertebrates from the Wealden of Bernissart.

DURING a recent visit to the West Prussian Provincial Museum, at Danzig, Dr. A. Nehring identified a portion of skull of the Saiga Antelope obtained from a superficial deposit near Graudenz, where many other fossil bones have been found. This is the first definite record of the occurrence of the Saiga among the "Diluvial Fauna" of Germany.

A NEW public museum has recently been opened at Kasan. The collections, says *Nature*, comprise numerous ornaments of gold and silver, various arms and implements from the former kingdom of the Volga Bulgars, modern decorative art of the Kasan Tartars, dress and implements of the Chuvashes, Cheremisses, and Mordves, and nearly 1,500 stone implements from the basins of the Volga and Kama. Alexandria also has opened a public museum, chiefly devoted to Greek, Roman, and Coptic antiquities.

THE cost of Lieutenant Peary's last expedition to Inglefield Gulf will, says the *American Naturalist*, be repaid by his observations and collections in ethnology, meteorology, and other branches of science. The scientific results of the relief expedition are also of great value, and the large collections made by it will go to the American Museum of Natural History in New York, and the Museum of Kansas University.

THE medals of the Royal Society are awarded as follows:—the Copley Medal to Professor Karl Weierstrass for his investigations in pure mathematics; a Royal Medal to Professor J. A. Ewing for his researches on magnetic induction in metals; a Royal Medal to John Murray of the "Challenger"; and the Davy Medal to Professor W. Ramsay for his share in the discovery of argon, and for his discoveries regarding the gaseous constituents of minerals.

The following are recommended for election as officers and council for 1896:—President, Sir Joseph Lister; Treasurer, Sir John Evans; Secretaries, Professor Michael Foster and Lord Rayleigh; Foreign Secretary, Dr. E. Frankland; other members of the council, W. Crookes, Sir Joseph Fayrer, L. Fletcher, Dr. W. H. Gaskell, Dr. W. Huggins, Lord Kelvin, Professor A. B. W. Kennedy, Professor H. Lamb, Professor E. Ray Lankester, Professor C. Lapworth, Major MacMahon, Professor J. H. Poynting, Professor A. W. Rücker, O. Salvin, Professor Marshall Ward, and Admiral Wharton.

ON the evening of Thursday, October 31, the Royal Society opened its Session with an informal social meeting of Fellows only. The come-as-you-please arrangement was much appreciated, and is likely to be repeated. There were a few exhibits, but the main purpose of the evening was conversation. It must have occurred to many people that the rooms and organisation of many of our learned societies might well be utilised a little more for purposes of good-fellowship. The Cosmos Club at Washington broaches a barrel of beer and hands round long clays. With us, early closing is in force, and thirsty ones are put off with the presidential announcement that "tea and coffee are served upstairs."

MISS JOSEPHINE E. TILDEN has been awarded the Albert Howard Fellowship for her work on American fresh-water algæ. The Baly Medal of the Royal College of Physicians has been awarded to Dr. W. H. Gaskell, of Cambridge.

THE Royal Academy of Belgium offers a gold medal for the best original memoir, written either in French or Flemish, on each of the following subjects:—(1) The intervention of phagocytes in the development of Invertebrata. (2) The phosphates and carbonates in the soil of Belgium, giving the horizons and localities of all minerals referred to. (3) The peripheral nervous system of *Amphioxus*, especially the constitution and genesis of the roots of the sensory nerves. (4) The mechanism of the cicatrisation of plants. The manuscripts must be sent to "M. le secrétaire perpétuel, au Palais des Académies, Bruxelles," before August 1, 1896, signed, not with a pseudonym, but with a device, which must be repeated on a card containing the name and address of the author and sent with the MS. in a sealed envelope. We note with pleasure that the Academy insists on exactness of quotation: authors must give the editions and pages of the works cited. We recommend this earnestly to our own contributors.

THE Royal Society of New South Wales offers a medal and a sum of £25 for the best communications on original research in the following subjects:—"The Origin of Multiple Hydatids in Man"; "The Occurrence of Precious Stones in New South Wales, with a description of the Deposits in which they are found"; "The Effect of the Australian Climate on the Physical Development of the Australian-born Population"; "The Physiological Action of the Poison of any Australian Snake, Spider, or Tick"; "The Chemistry of the Australian Gums and Resins"; "The Embryology and Development of the Echidna or Platypus"; "The Chemical Composition of the Products from the so-called Kerosene Shale of New South Wales"; "The Mode of Occurrence, Chemical Composition, and Origin of Artesian Water in New South Wales." Particulars can be obtained from the honorary secretary, 5 Elizabeth Street, Sydney.

THE *Standard and Diggers' News* publishes in its number for September 7 portraits and biographies of Dr. A. H. Exton (president), Dr. Guybon Atherston

(vice-president), and Mr. David Draper (secretary), the three principal officers and founders of the Geological Society of South Africa.

THE third French Congress of Medicine will be held in 1896 at Nancy, under the presidency of Dr. Pitres, Dean of the Faculty of Medicine of Bordeaux.

PROFESSOR E. D. COPE has been elected President of the American Association for 1896. The meeting will be held at Buffalo in August. B. K. Emerson will preside over geology; Theodore N. Gill over zoology; N. L. Britton over botany; and a woman, Alice C. Fletcher, over anthropology.

A TELEGRAM from Aden, dated November 3, announces the safety of the Donaldson-Smith expedition. Letters have been received from Dr. Forsyth Major, dated August 27, from Central Madagascar, announcing the welfare of himself and his companion, Mr. Robert.

THE German Committee for the exploration of the South Polar regions has decided to send two vessels southwards from Kerguelen Island, and to leave full liberty of action to the leaders. The total sum to be allotted for the expedition, which is to last three years, is fixed at 950,000 marks.

DR. W. J. MCGEE, of the Bureau of American Ethnology, has started, says *Science*, to explore the hitherto unknown portion of Sonora county in Mexico, and Tiburon Island on the coast of Mexico, inhabited by the treacherous and blood-thirsty Seri Indians.

PAYMENT by results has long been the bugbear of those trying to do good educational work under an official system. We are therefore glad to hear that the Science and Art schools and classes throughout the country have been informed of a minute of the Committee of Council on Education sanctioning attendance grants, at least as an experiment for a limited time. According to this plan, the grant will depend partly on attendance and partly on examination results. The adoption of the scheme by any local committee is optional, but only those schools or classes whose teaching and equipment are reported to be thoroughly satisfactory can elect to come under it.

ERRATA.

WE regret that on the wrappers of recent numbers two gentlemen have been assigned to posts which they do not occupy. Mr. H. N. Dickson, one of the assistant secretaries during the meeting of the Geographical Congress, was described as its Secretary; and Mr. H. A. Miers, the editor to the Mineralogical Society, was called its Secretary. We apologise to the rightful holders of the titles in question.

NOTICE.

TO CONTRIBUTORS.—*All communications to be addressed to the* EDITOR *of* NATURAL SCIENCE, *at* 22, ST. ANDREW STREET, HOLBORN CIRCUS, LONDON, E.C. *Correspondence and notes intended for any particular month should be sent in not later than the* 10*th of the preceding month.*

TO THE TRADE.—NATURAL SCIENCE *is published on the* 25*th of each month; all advertisements should be in the Publishers' hands not later than the* 20*th.*

THE "CHALLENGER" NUMBER.—*In reply to enquiries, we remind our readers that, although the* FIRST *edition of this ran out of print immediately, there are still some copies of the* SECOND *edition to be obtained at the usual price—* ONE SHILLING. *No more will now be printed, so orders should be sent at once.*

SPECIAL "CHALLENGER" NUMBER.

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NATURAL SCIENCE:

A Monthly Review of Scientific Progress.

JULY, 1895.

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